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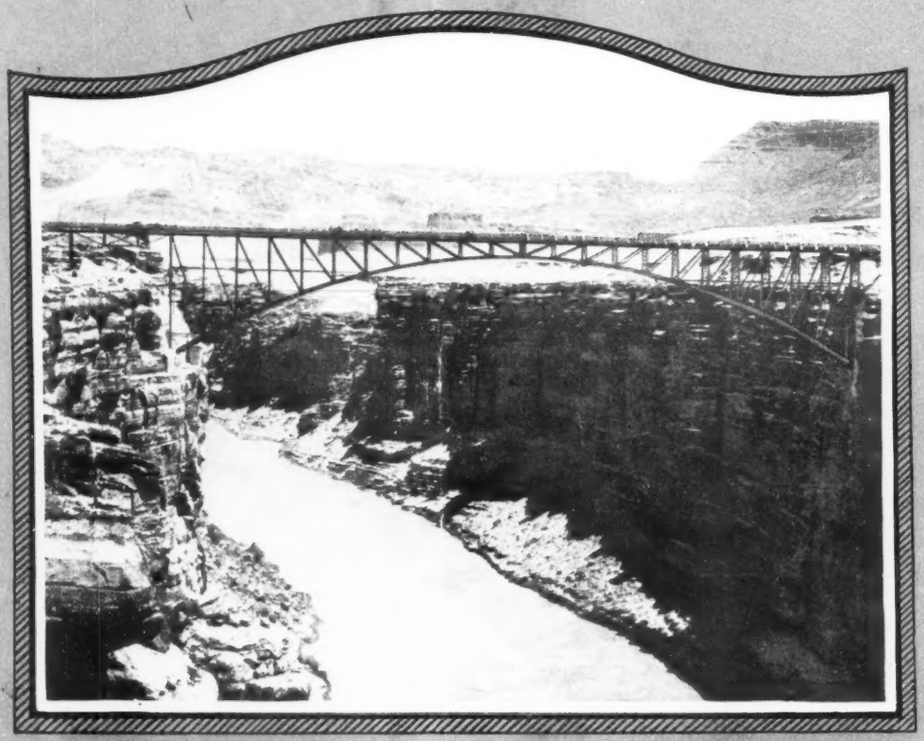

Ewing Galloway, New York

HIGHWAY BRIDGE ACROSS THE GRAND CANYON OF THE COLORADO RIVER. IT IS 400 FEET ABOVE THE STREAM AND SAVES 200 MILES OF TRAVEL.

Great National Memorial to Washington
R. G. Skerrett

How Tools for Oil-Well Drilling Are Manufactured
C. H. Vivian

Making Chewing Gum For the Multitude
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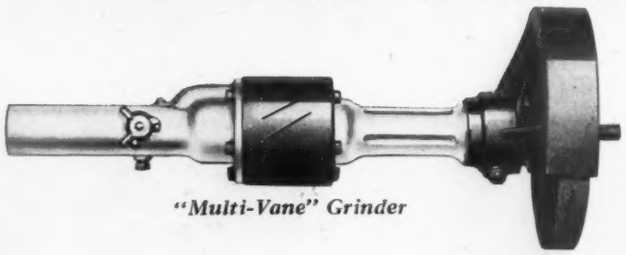
Announcing

A more Complete Line of "Multi-Vane" and Piston Type Grinders



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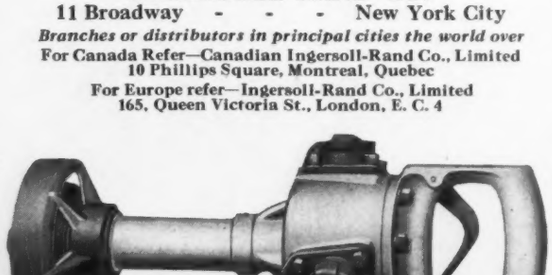

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As It Seems To Us

BUSINESS TRAINING FOR ENGINEERS

ENGINEERS frequently find themselves beyond their depth when placed in positions calling for some skill in business administration. This is unfortunate because there is a steadily increasing demand for engineers capable of filling jobs requiring the exercise of executive responsibility. In these cases engineering knowledge is essential so that the man may the better discharge his duties in connection with an industrial organization.

Recognizing the need of men trained both for business and for engineering, the Massachusetts Institute of Technology will open next fall its newly created Department of Business and Engineering Administration—the course in engineering serving as a background or foundation for instruction in commercial and industrial management. The wisdom of this procedure is amply warranted by the experience of the institute.

Since 1914, the institute has had a course in engineering administration. A survey of the activities of a representative number of the graduates so trained has disclosed that more than half of them were holding important positions of executive responsibility within seven years following graduation, while within an interval of nine years three-quarters of the group had become executives. The situation reveals how much more than most of us are aware the engineer has found lucrative work in fields of service apparently not directly identified with engineering pursuits. The discovery is of twofold significance: first, it immediately broadens the potential scope of usefulness for graduate engineers, and, next, it indicates plainly the higher plane upon which many industries and commercial undertakings are operating today. The engineer instead of being appealed to as an occasional consultant has now become a very active and a continual participant in the work of the organization with which he is closely identified.

ICE CREAM FOR THE POPULACE

JUST how much ice cream we consume annually was revealed recently by the Chief of the Bureau of the Dairy Industry of the United States Department of Agriculture. The amount totals 348,000,000 gallons. To produce that quantity, 6,000,000,000 pounds of milk were required—representing the yield of about 1,333,333 cows. In addition to the milk, the manufacturers used 209,000,000 pounds of butter fat, 243,000,000 pounds of sugar, 174,000,000 pounds of milk solids, and the relatively modest measure of 5,000,000 pounds of food gelatine. In the neighborhood of 4,000 ice-cream factories were engaged in the business when statistics were gathered two years ago.

Back in 1905, our per capita consumption annually was 1.04 gallons, while in 1928 that consumption had increased to 2.9 gallons. The farmer gets the benefit of this business just when his cows are giving the most milk; and the general public is the gainer because ice cream is now recognized by dietitians as a food of a superior sort.

WINGS FOR US ALL

HOW does the idea appeal to you? We have it on the authority of Dr. LUCIEN BULL, one of the directors of the Marie Institute of Paris, that the time may come when it will be feasible for any of us to have wings fitted to us and then to proceed whither we wish via the air and the exercise of our own muscles. Doctor BULL declares: "A man who is able to run upstairs ought to be able to fly. All that is necessary is to adapt ourselves to the air. I don't mean to say there are no problems to be overcome. There are many of them. But I am convinced the development of light, strong, metal-like magnesium-aluminum will continue until some alloy is perfected from which human wings weighing about a pound can be fashioned." Doctor BULL stresses how much more pleasant it would be to fly to work instead of having to resort to crowded cars and other conveyances, as at present.

The good doctor loses sight of the fact that millions of people now choose to ride despite the fact that Nature has equipped them with legs capable of carrying them to their several destinations; and we just wonder whether people equipped with wings, that require the expenditure of energy, would not prefer to fold these attachments and perch upon any convenient vehicle that would transport them without effort on their part. When would the office-bound read their newspapers or get a thrill out of *The Age for Love* or *The Other Side of the Curtain?*

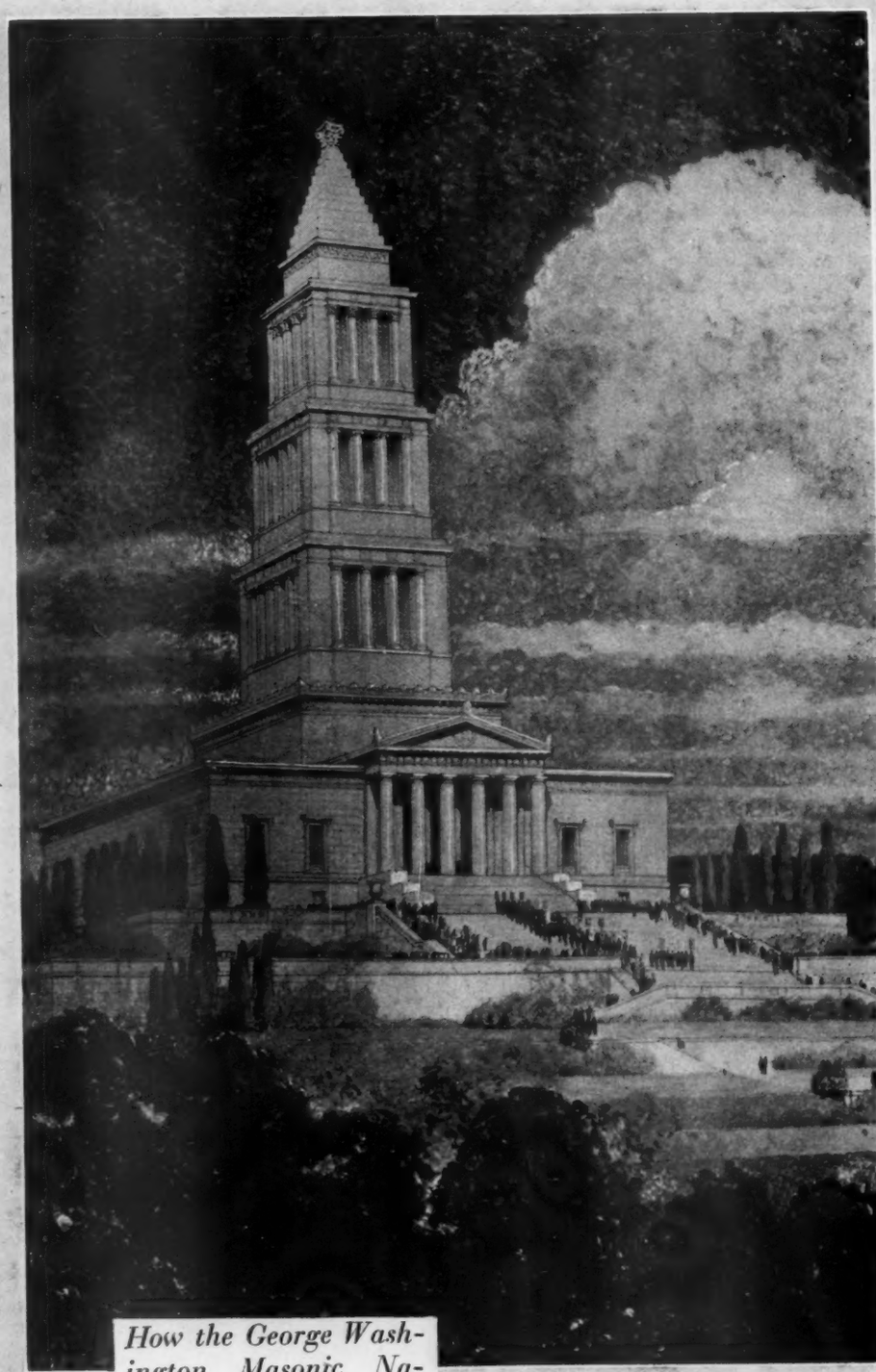
If man had at his disposal wings such as the French scientist contemplates, it would not be safe for him or others to let him loose aloft until he could use them efficiently; and we have seen crows and other creatures of the air battling awkwardly and unsuccessfully against a moderately stiff wind. Only the other day an expert of the New York Aquarium said some unhandsome things about the lack of skill displayed often by the flying fish when making a "landing"; and we fancy that the flying fish is more likely to keep his mind on his job than the average human being with his tendency towards distraction. Absent-mindedness might easily be fatal to human kind although only momentarily disconcerting to a flying fish.

IN QUEST OF NOCTURNAL CALM

AN enterprising hotel in New York City recently completed a three weeks' check-up on the manner in which its guests managed to sleep during the nights of the period in question. The questionnaire was a contribution to the researches of the City Noise Abatement Commission. We just naturally wonder how far inquiries of this sort will lead ultimately to that blessed state of nocturnal calm that will make wakefulness inexcusable.

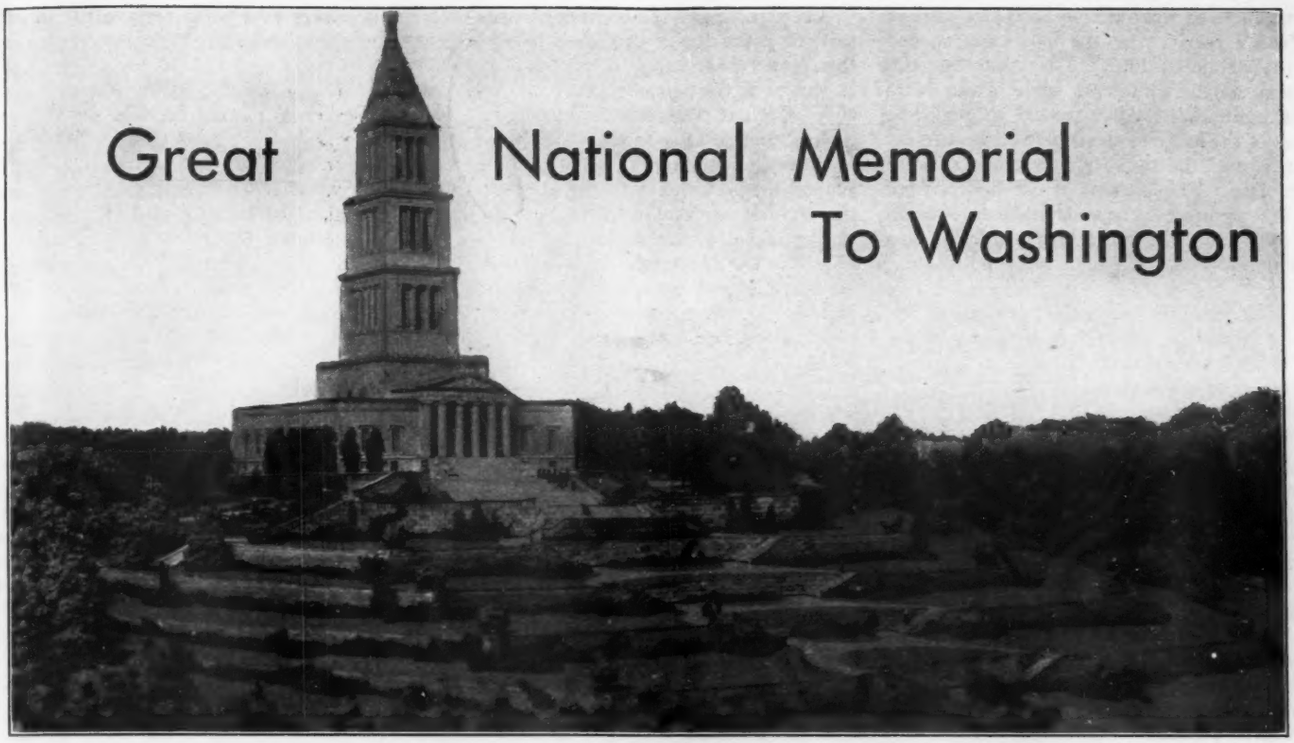
One has to know New York City only casually to realize how difficult it would be to insure quiet throughout its entire limits. It is a community of ceaseless change both above and below ground. Improvements, alterations, and repairs are pushed forward continually, and most of these call for haste—haste so that towering structures shall arise quickly in order that they may be occupied promptly, and so that highways may be reconditioned with the least possible interference with the tides of traffic that normally roll to and fro upon them during many hours of nearly every day. Speed in accomplishing the diversified tasks involved necessitates the extensive employment of mechanical facilities, and these are unavoidably noisy. A steam shovel is not a pleasant neighbor when one seeks sleep, but the power shovel is the handiest and the most effective means of digging an excavation and in finally demolishing the foundations of razed structures preliminary to rearing a bigger and better building.

And even if it were practicable to silence these various machines, there would still remain other sources of noise that are equally disturbing and far more prevalent. Broadcasted radio is not an unmixed boon, especially when your neighbors are wide awake and merry and their tastes dissimilar. We can recall some sections of New York City where the din day and night from this source is nerve-racking. And we know of parts of the Metropolis where parties in nearby rooms or buildings make sleep nearly impossible before the participants go their several ways or subside through sheer exhaustion. Unless these and kindred annoyances can be silenced after nightfall, we see no good and sufficient reason for picking on the machines that are doing really useful work with much desired dispatch. Some communities just naturally go to sleep with the barnyard denizens, and then the cricket and the katydid alone remain vocal; but we seriously doubt if anything approaching that degree of restful calm can be assured in any large city. And, finally, restful sleep depends upon a number of conditions—purely personal to those immediately concerned: and these conditions, serious as they may be, are beyond the control of any commission bent upon noise abatement.



How the George Washington Masonic National Memorial in Alexandria, Va., will appear when completed.

Great National Memorial To Washington



By R. C. SKERRETT

ON Shooters Hill, in Alexandria, Va., there is now nearing completion a splendid memorial to George Washington, the Mason. The site chosen for the edifice is the exact spot selected nearly 140 years ago by Jefferson and Madison as the likeliest location for the Nation's Capitol. George Washington objected because he owned property nearby and did not care to invite criticism. Even so, the memorial reservation now includes some of the land embraced by Washington's much larger tract.

While it was probably best to place the seat of Government in the District of Columbia—recalling how Washington City has been transformed since the Congress first met there 130 years ago, still there is no denying that Alexandria is the most appropriate location for the rearing of a structure designed primarily to commemorate George Washington's 47 years as a member of the great fraternity that now does him honor in this way.

From the day when Washington, a lad of fourteen years, took up his residence at Mount Vernon, until his death in 1799, Alexandria was truly his home town. Alexandria was his voting place and the market for the things grown and raised at Mount Vernon. He became a member of Alexandria's Town Council and a justice in its magisterial court. When Alexandria expanded, Washington made the surveys for its projected streets. He represented the community in the House of Burgesses; he founded the town's fire department and its first free school; he owned a pew and attended service in Christ Church; he was Master of Alexandria's Masonic Lodge; and he was a director and a stockholder in the local bank. Alexandria was his place of business; and he continually took part in the development of its industries and in its significant social life. It was in Alexandria that he held his last military review, gave his last military command, and cast his last vote. Alexandria's physicians attended him in his last illness, and his fraternal brothers of Alexandria Lodge No. 22 performed the services at his burial.

Some will ask: "Why build a great national masonic memorial? Why cannot the ideals of his life be placed before men in the form of the printed word and thus serve as an inspiration to higher things?" And the answer is—we are living in a rapidly moving age in which material symbols serve best to arrest the eye and to tell a story. Therefore, the structure now rising in Alexandria is thus intended to impress the hastening millions and to bring home to them the example of that outstanding patriot where the printed word might failed to do so.

In 1788, Washington was made Charter Master of Alexandria Lodge No. 22 of Virginia to serve until December 20 of that year, and upon the latter date he was unanimously elected to succeed himself for the full term. Washington's connection with the Alexandria Lodge not only brought the institution into immediate prominence but it also exercised a salutary influence upon the public. Most of the leading citizens in the community became active members; and the lodge was conspicuous in most of the important ceremonies in that section of the country. The first function of a public nature in which the lodge played a prominent part was that of laying the corner stone of the District of Columbia—the District then lying partly in Virginia. The Rev. James Muir, in concluding his address after the stone was laid, said: "May this stone long commemorate the goodness of God in those uncommon events which have given America a name among nations. Under this stone may jealousy and selfishness be forever buried. From this stone may a superstructure arise, whose glory, whose magnificence, whose stability, unequaled hitherto, shall astonish the world, and invite even the savage of the wilderness to take shelter under its roof." On September 18, 1793, George Washington laid the corner stone of the Capitol in the City of Washington. Then, as in so many other of his activities, Washington stood forth as a veritable master builder—true to the traditions of the ancient order with which he had allied himself on the eve of reaching his legal majority.

Alexandria Lodge No. 22 became known later as Alexandria-Washington Lodge No. 22; and within it has been preserved for a long while many relics of Washington—Masonic and otherwise. For all the hundred years the lodge housed these mementos, their presence there aroused but little general interest. Then Mount Vernon and Washington became linked by an electric railway that carried yearly thousands of sight-seers to the erstwhile home of the Nation's first president. That railroad was instrumental in bringing to the attention of those people the notable wealth of Alexandria's historic associations, and Alexandria-Washington Lodge No. 22 became at the same time an increased object of interest. Relic hunters developed into an insidious menace, and their depredations emphasized the need of greater protection and, incidentally, disclosed the desirability of a fireproof structure in which these priceless Washingtonia could be housed securely for the benefit of generations to come. This can

be appreciated when it is recalled how visitors increased yearly after the lodge was opened to the public in 1907. That year but 600 persons sought admission, while fifteen years later more than 40,000 passed through the doors of the lodge in the course of the twelvemonth, and the number has grown steadily ever since. The Masons of Alexandria were the first to move in the matter of safeguarding the relics; and they called into being what was designated the Local Memorial Temple Committee.

That committee, with the approval of the Grand Master of Masons in Virginia, in the fall of 1909 extended an invitation to the several Grand Masters of the United States to assemble in Alexandria on February 22, 1910, for the purpose of organizing a national masonic memorial association with the object of erecting a memorial to Washington, the Mason. The convention took place on the date set and approved and endorsed the proposed erection in Alexandria of a Masonic Temple as a memorial to George Washington.

The second meeting of the association took place in February of 1911, and in 1913 a constitution was formally adopted. Article II of that instrument consisted of the following declaration of purpose: "The objects of this Association shall be to erect and maintain in the City of Alexandria, Virginia, a suitable Memorial Temple to George Washington, the Mason, one which shall express in durability and beauty the exalted and undying esteem of the Freemasons of the United States for him in whose memory it shall stand through the coming years. To provide a place where the several Grand Jurisdictions, members of the Association, may perpetuate, in imperishable form, the memory and achievements of the men whose distinguished service, zealous attachment, and unswerving fidelity to the principles of our Institution merit particular and lasting reward. To create, foster, and diffuse a more intimate fraternal spirit, understanding and intercourse between the several Grand Jurisdictions and Sovereign Grand Bodies throughout the United States and her insular possessions, members of this Association to cherish, maintain and extend the wholesome influence and example of our illustrious dead."

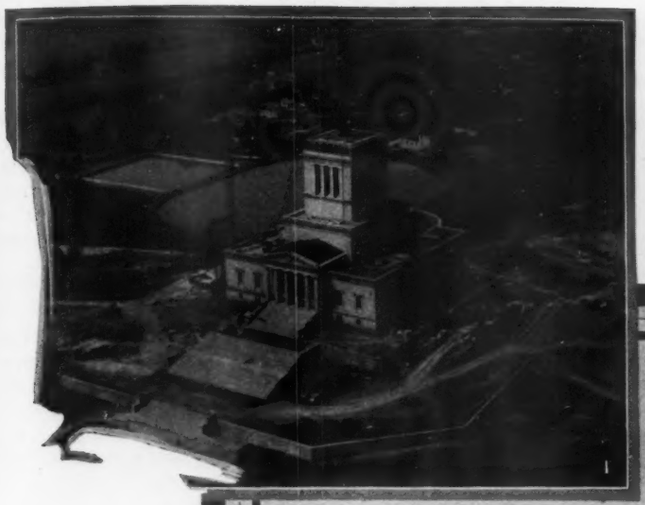
Top—Architectural perspective of Memorial Hall showing the eight polished green-granite columns flanking the heroic statue of George Washington. Bottom—Longitudinal section through the Masonic Temple. At the right or rear is the amphitheater.

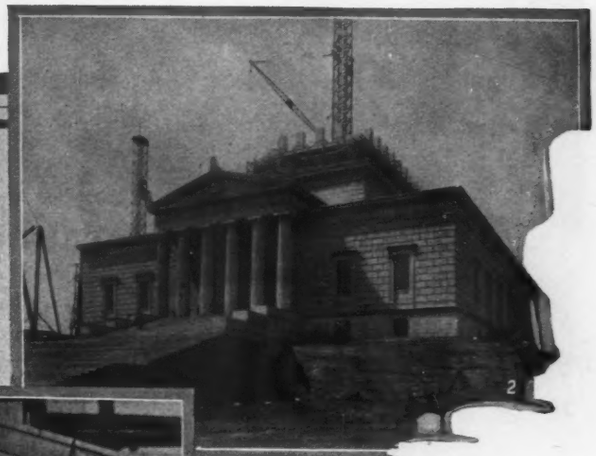
When sufficient funds were in hand, the task of preparing a suitable design and of then supervising construction was awarded to Helmle & Corbett, architects of New York City—Corbett, Harrison & MacMurray, successors, and to Osgood & Osgood, consulting architects, of Grand Rapids, Mich. The general design adheres to the classic lines of the architecture of Greece and Rome. The supporting structure will be surmounted by a tall tower patterned in a measure after kindred Ziggurat towers such as the ancients built at the entrances of Mediterranean harbors and equipped with flares to guide storm-tossed mariners into sheltering havens. The tower on the temple in Alexandria is intended to serve as a symbol of the life of George Washington and to be a guiding light and an inspiration in statesmanship and Masonry to the men of America of today and to those that shall come to carry on in future generations.

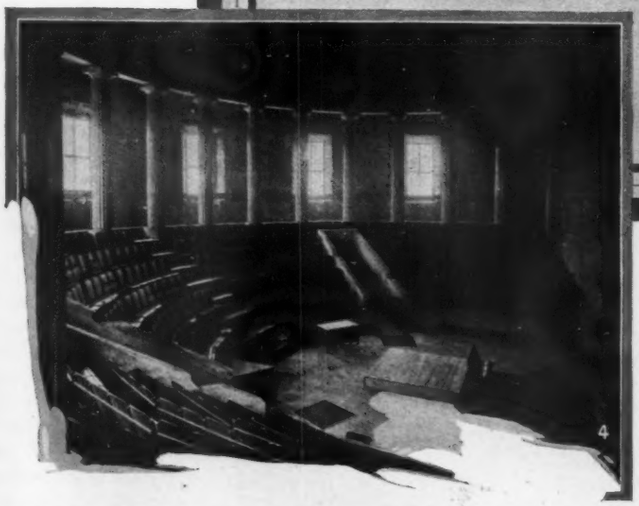
The building of the temple was awarded The Cranford Company of Washington, D. C., on the second day of June, 1922; and three days later ground was broken with appropriate ceremonies. The first work consisted of making a large excavation preparatory to forming the extensive and massive concrete mat which constitutes the foundation for the edifice. All told, 135,000 cubic yards of earth were removed in preparing the site, and that earth was utilized to form the terraces on the east or approach slope of the hill. With the excavating finished, the next step was to ascertain the bearing capacity of the underlying ground—a bed of clay 117 feet thick overlying sand. Careful and exhaustive bearing tests were made, and as a result of these the nature and the dimensions of the foundation mat were decided upon. In this vital feature of the undertaking, Daniel Moran, of Moran, Maurice & Proctor, of New York City, was the guiding authority, being a specialist in foundation work. The problem was to get a mat that would stay in place and which would carry the load represented by the completed temple despite the penetration of water into the surrounding and underlying soil during protracted periods of wet weather.

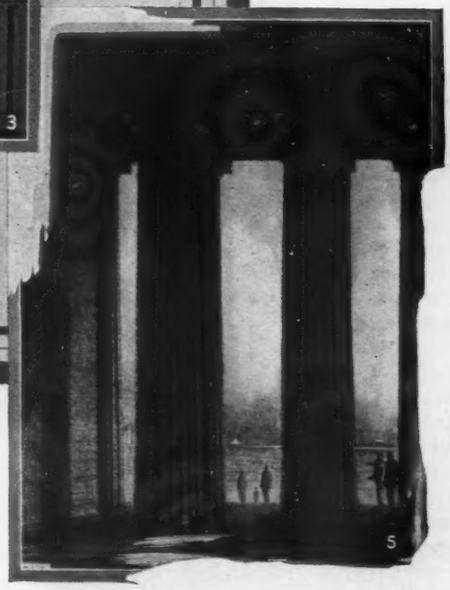
The foundation is what is technically described as an articulated mat, and it consists of fifteen great girders of reinforced concrete. The center portion of the mat has a maximum thickness of 9 feet, and from there outward it is stepped down successively until it becomes 4 feet 6 inches thick directly beneath the outer walls of the temple structure. The mat is made up of 9,000 cubic yards of concrete reinforced with 720 tons of carefully placed steel rods, and has an area of 36,825 square feet. The concrete was poured as a continuous performance in 302 hours of elapsed time. Every batch of concrete was mixed in accordance with a prescribed formula and poured under the personal supervision of Carroll A. Warthen, superintendent and engineer in charge for The Cranford Company.

With the mat completed and ready to bear its designed load, work on the temple, itself, was started on November 1, 1923, when the corner stone was laid. On that occasion there was assembled the largest gathering of Blue Lodge Masons in the history of the fraternity; and more than 35,000 people were present either on the site or nearby. The President of the United States, the Chief

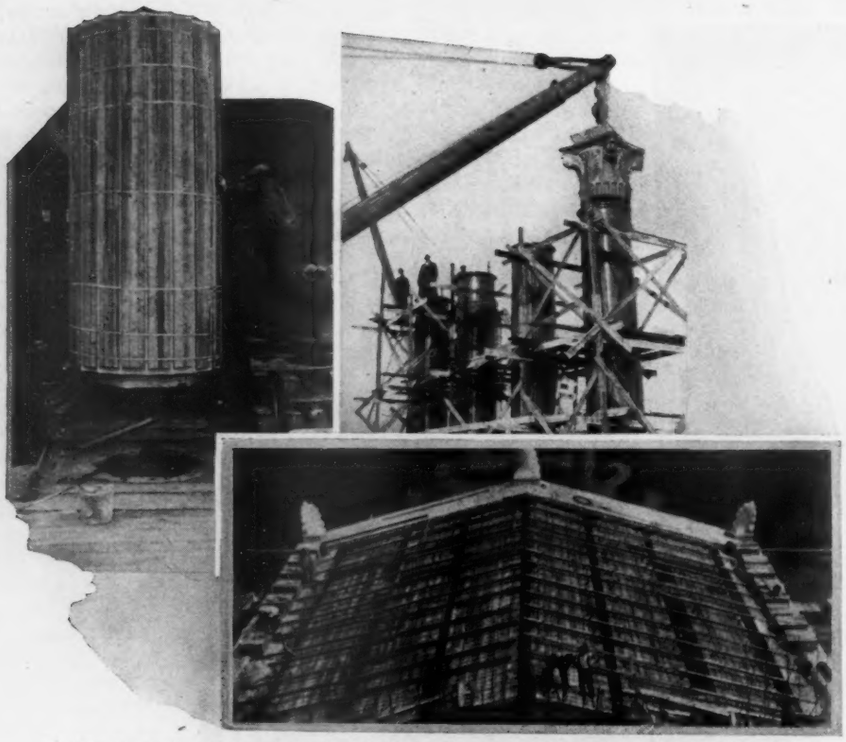








1—As the George Washington Masonic National Memorial appeared from an airplane some time last year. 2—Close-up of the eastern front of the temple giving a good idea of the structural details of the portico. 3—The medallion of George Washington above the portico of the temple. 4—Amphitheater, at the western end of the temple, capable of accommodating from 1,000 to 1,200 people. 5—Vista of the National Capital seen when looking out from behind the columns of the portico.



Left—Lowering into place the bottom drum of one of the stone columns. Right—Putting the capital section on one of the eight green-granite columns now adorning the interior of Memorial Hall. These columns were erected before the enveloping walls were reared. Bottom—The massive roof of the portico nearing completion.

Justice of the Supreme Court, and many members of the Cabinet were also there to pay tribute to Washington and to the fraternity. Since that date, the edifice has steadily gathered form and height—no work being undertaken until money for it was actually in hand. If funds were available it would be practicable to carry the building from its present state to completion in the course of eighteen months. In short, this could be done by February 22, 1932—the two-hundredth anniversary of the birth of Washington, if each Mason in the United States would contribute the modest sum of $1.75!

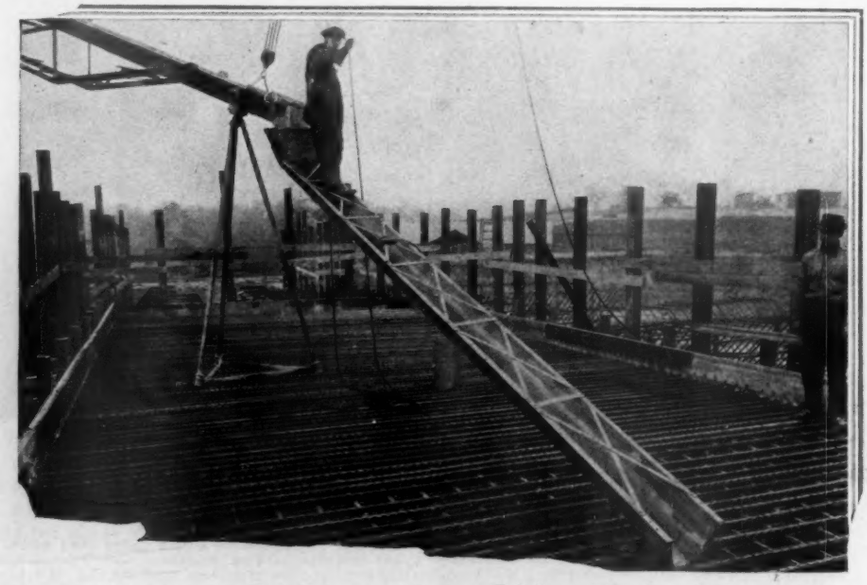
The temple faces the East, and is approached by seven terraces. The scheme for the planting and the arrangement of the temple setting has been planned by Olmsted Brothers, landscape architects, of Brookline, Mass., and is being executed under the immediate supervision of Carl Rust Parker of that firm. The whole reservation covers an area of 40 acres, and there are 8½ acres in the front lawn. The building, itself, rests upon an area of 2¼ acres. East and west, the structure has an over-all longitudinal dimension of 240 feet, and its width is 168 feet.

The tip of the tower is 333 feet above ground level, or 440 feet above sea level. From the tower, when completed, it will be possible to command a far-flung view embracing many points of great historic interest and significance. The exterior walls of the edifice are of Conway pink granite—a rock of notable strength and weathering qualities. The stone comes from the quarries of the Maine & New Hampshire Granite Corporation, at Redstone, N. H.

There is no structural steel in the temple—the exterior granite walls being backed up with reinforced concrete. The total thickness of the walls ranges from 42 inches to 16 inches, agreeably to the load to be borne by them. All walls rise directly from the foundation, and there are no columns in the usual sense of the term except such as are of structural stone and which, in their turn, transmit their loads to the underlying reinforced-concrete mat. The aim of the architects has been to provide a maximum of strength so that the temple will stand secure for many hundred years to come.

The entrance to the temple is by way of a portico dignified by eight Doric columns 33 feet high, 5 feet 10 inches in diameter at the base, and each made up of three drums and a cap weighing 63 tons. The portico leads into the great atrium, comprising the main central room of the structure and forming the Memorial Hall in which will be set a statue of Washington of heroic size. The hall is 100 feet long and 70 feet wide. Within it, and supporting the weight of the tower, are eight polished columns of green Conway granite each of which has a diameter of 4½ feet and a height of 39 feet. Surrounding the hall are various rooms that will be devoted to Masonic purposes. One of these will be a replica of the old Alexandria-Washington Lodge room; and in it will be deposited the invaluable collection of Masonic and personal effects of Washington that are owned by that lodge. In addition to Memorial Hall, there will be at the western or back part of the temple an auditorium capable of seating between 1,000 and 1,200 persons. Furthermore, the structure will contain executive and administrative offices of suitable sizes, as well as a Blue Lodge Room and rooms for other Masonic bodies and their regalia.

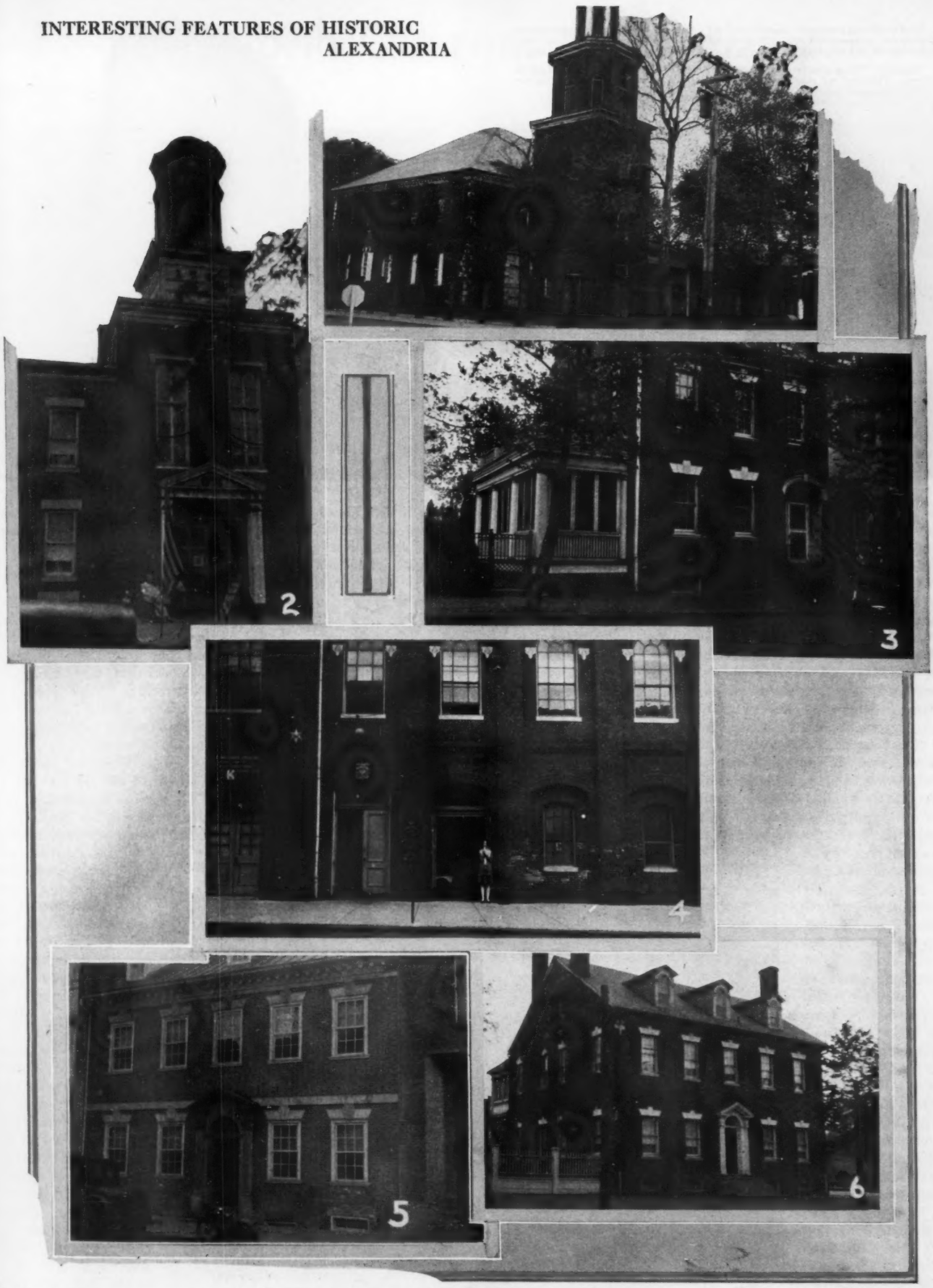
In its present unadorned state the building internally is especially interesting because one can see much of the structure in its nude strength and grasp how the reinforced concrete has been modeled and distributed in order to provide the full measure of enduring rigidity prescribed. There are 300 tons of concrete in the anchorages of the arch at the front and the rear of the portico ceiling; and there are 270 tons of cut stone in the flat arch forming that ceiling. In the upper section of Memorial Hall—that is, the third floor system which constitutes the foundation for the superposed tower, there are four massive girders made up of 1,150 cubic feet of concrete stiffened with 7½ tons of reinforced steel. As in the case of the foundation mat, every bit of this concrete has been mixed, poured, and distributed with the utmost care.



Ready to pour concrete for one of the great girders of the foundation mat. Note the massive arrangement of the reinforcing steel.

Besides looking down upon the City of Alexandria with its quaint

INTERESTING FEATURES OF HISTORIC ALEXANDRIA



1—Old Christ Church where Washington worshiped from time to time. 2—Historic fire department founded by Washington in 1774. 3—Here it was that "Light Horse Harry" Lee once lived. 4—Present quarters of Alexandria-Washington Lodge No. 22. 5—Gadsby's Tavern, now in course of rehabilitation, was intimately identified with George Washington and the people of his day. 6—Fine example of an Alexandria home that reflects the architectural dignity of the days when George Washington and his fellow Alexandrians were making history.

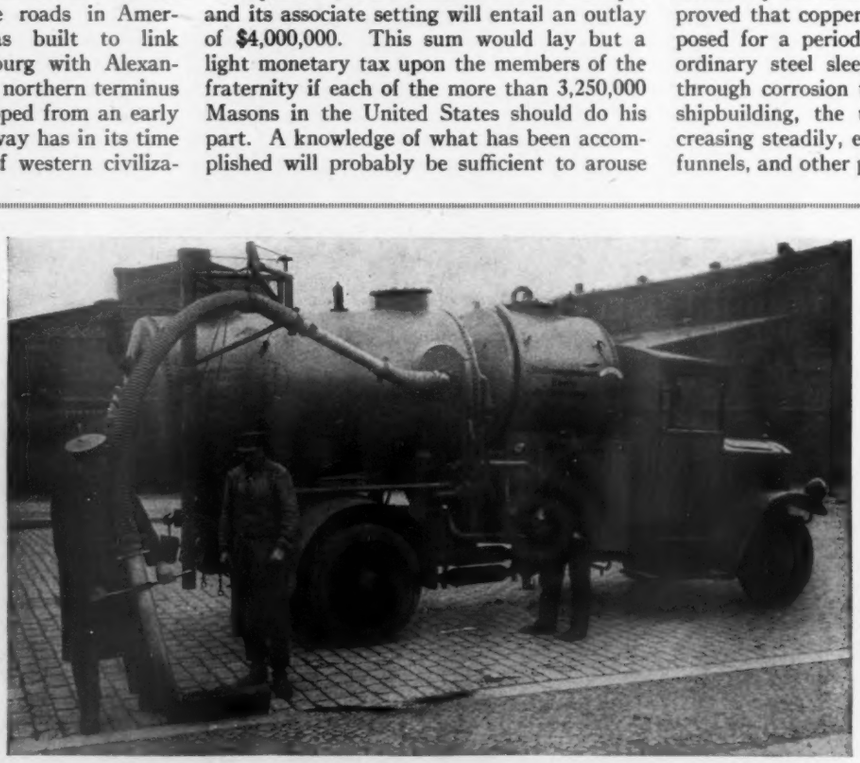
Left—Temporary location of the electrically operated chimes presented by Louis A. Watres, president of the George Washington Masonic National Memorial Association.

Right—This chair was the one used by George Washington when Master of Alexandria Lodge No. 22. It is now carefully cherished by the Lodge.

homes and other structures identified with the days of Washington, one can see from the temple portico the National Capitol to the north and the broad sweep of the Potomac southward toward Mount Vernon. All in all, the site is one to inspire because of its proximity to places that have had much to do with our historic past. At the foot of the eminence upon which the temple stands, and skirting that hill on the south, is the present-day survival of the Kings' Highway, one of the oldest and most famous of the roads in America. This highway was built to link Jamestown and Williamsburg with Alexandria, which was the road's northern terminus in Virginia. It was developed from an early Indian trail; and the highway has in its time witnessed the transition of western civilization, as marked by a little colony under Capt. John Smith, to that status of human progress exemplified by the surpassing power and influence of a united and populous continental nation. Truly, no better location could have been chosen for a memorial to Washington, the Mason and the master builder of a nation.

Past Grand Master Louis A. Watres, president of the George Washington Masonic National Memorial Association, has thus, in part, expressed the idealism underlying the project: "Into this Memorial to our hero we place the highest achievement of architectural skill and the most enduring materials to honor the model Mason and citizen who has earned undying renown. In its beauty, symmetry and splendor it will stand before the world as a visible expression of the stability, indestructibility and permanence of our fraternity. It will be more than a memorial to Washington. It will be a lasting monument to civil and religious liberty, to stable and orderly Government, not only in our day, but for future generations. It will emphasize this great message to posterity."

As planned, it is estimated that the temple and its associate setting will entail an outlay of $4,000,000. This sum would lay but a light monetary tax upon the members of the fraternity if each of the more than 3,250,000 Masons in the United States should do his part. A knowledge of what has been accomplished will probably be sufficient to arouse to action those that have not so far contributed to this splendid and monumental undertaking.



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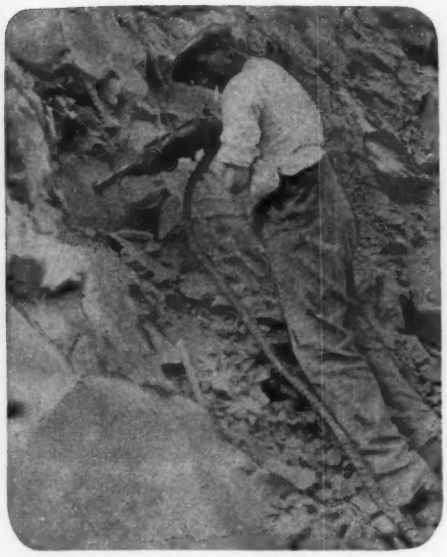
Cleaning catchment basins of sewerage systems is usually a dirty job, but here we see it done under highly sanitary conditions by a vacuum cleaner especially designed for the purpose and in the service of the Berlin Street Cleaning Department.

COPPER-STEEL

TESTS under service conditions, reports *The Engineer*, have now fairly well established that steel containing a small percentage of copper, say 0.2 per cent, offers considerable resistance to corrosion. Experiments conducted by the German State Railways have proved that copper-bearing steel sleepers, exposed for a period of seven years alongside ordinary steel sleepers, lost far less weight through corrosion than did the controls. In shipbuilding, the use of copper-steel is increasing steadily, especially for decks, masts, funnels, and other parts at all times subjected to the destructive action of the atmosphere.

Unpainted copper-steel is estimated by one observer to have from two to two and a half times the life of copper-free steel; and he has determined as the result of research that the reduction in thickness of copper-free steel is anywhere from 70 to 90 per cent as against 4 per cent for copper-bearing steel, all other conditions being equal. In view of these facts, it is interesting to learn that the transmission towers for the Central England Electricity Scheme have been constructed of copper-steel not only to increase their service life but to cut maintenance costs.

Betchworth Quarries Modernized



"Jackhamer" at work drilling holes preparatory to blasting.

History of Dorking Greystone Lime Company Offers an Interesting Contrast of the Old and the New in Quarrying Methods and Equipment

Breaking stone with a No. 58 pick for loading into trucks.

By MAJOR E. W. TAYLERSON*

SURREY, England, is known the world over as one of the beauty spots of the world. A comparatively short ride from the heart of London will bring one into the picturesque countryside comprising the hills and green fields of rural Surrey. The routes from London to Dorking and Reigate are known to nearly everyone who has explored the main highways of southern England. They constitute a favorite journey for tourists and for residents of the great Metropolis who seek leisure hours in the country.

Between these old towns of Reigate and Dorking lies Betchworth, a quiet and picturesque village of the true Surrey type. Here is Betchworth Clump—a circle of beech trees—well known as a landmark of the North Downs, and here also are located the works and quarries of The Dorking Greystone Lime Company, Ltd. The history of this company presents many interesting chapters that are identified not only with past famous engineering developments but also with modern methods and plant equipment. The works are of great interest from an engineering standpoint because of their association with members of the Perkins' family, pioneers in the use of high-pressure steam, to which reference will be made later on in this article.

The Dorking Greystone Lime Company, Ltd., was founded and incorporated in 1865 by the late William Finlay, great uncle of the writer—the present managing director, to develop lime manufactured from the greystone and white chalk of that district. Small wayside kilns had previously existed from time immemorial near sites where the greystone strata, running parallel with an old track known as the Pilgrim's Way, were clearly defined. The output of these early and primitive kilns not only supplied the needs of the agricultural community of the district but it was also transported by farm wagon to London, together with the local stone which was much favored and used in the building of such ancient edifices as Westminster Abbey. The early kilns were of very crude construction, and fired by wood cut from the then existing nearby forests. Labor employed was of both sexes—men and women working side by side stacking the stone, watching the fires, and drawing the lime.

In 1865, steps were taken to adapt the Hoffman kiln which, up to that date, had served only for the manufacture of bricks. The Hoffman kiln, unlike the older type, operated continuously in definite cycles, thereby effecting a considerable saving in coal, labor, and time. That same year a modified Hoffman kiln was built, and it is on record as the first continuous lime kiln used in England. Two years later witnessed the installation of a second continuous kiln—both being in service until the early part of this century.

In 1873 the company made an agreement with General Scott, the inventor of "Scott's" or "Selenitic Cement", for the development of his patents. Since that date large quantities of this product have been sold for building purposes. The Dietzch process for the manufacture of cement by a special kind of kiln was afterwards used for the making of lime. In 1887 two such kilns were erected at the Betchworth plant, and ten years later another pair, constructed on modified lines, were added.

In 1926 the company decided to do its quarrying with pneumatic equipment, and, accordingly, provided an air compressor, rock drills, picks, etc. These have been in continuous use ever since, and have brought about a marked saving in the cost of quarrying and of maintenance services. In the interest of economy, a type POV-2 oil-engine-driven compressor was subsequently installed. The unit, which operates on crude oil, consists of a 50-hp., single-cylinder, 4-cycle oil engine direct connected to a

Forge Cottages, Betchworth, England.

*Managing Director, The Dorking Greystone Lime Co., Ltd.

Left—Fryleigh Bridge spanning the picturesque River Mole. Right—Entrance to Betchworth churchyard.

2-stage compressor which has a capacity of approximately 250 cubic feet per minute and supplies air for "Jackhamers", picks, and other pneumatic tools. The air cylinder is mounted vertically above the oil engine, thereby saving floor space and requiring but a small engine room. The compressor and oil engine are direct connected to a common crankshaft, thus eliminating all transmission losses.

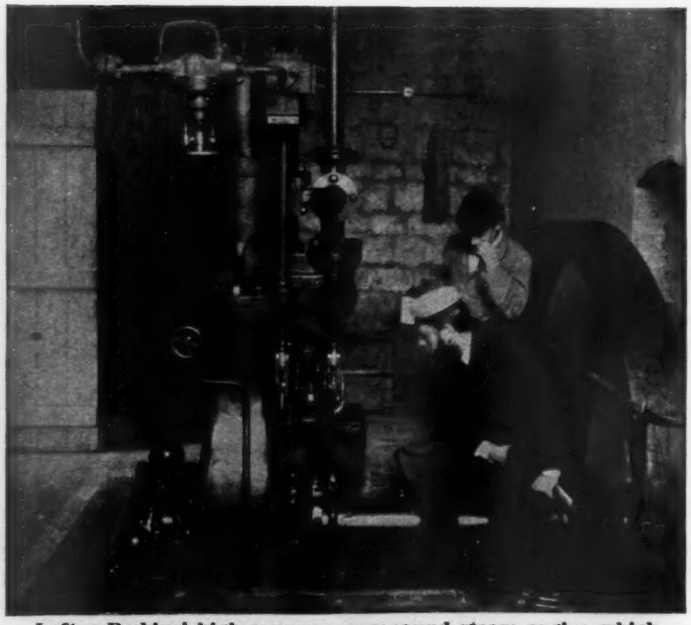
A BBRA-13 "Jackhamer" is used for drilling the stone. After blasting, it is broken up into the desired sizes by No. 58 picks. The stone is then loaded into trucks and transported from the quarry face to the kilns by a narrow-gage railway. In addition to this and other pneumatic equipment, a CCS air drill is used to do various repair jobs about the works. Thousands and thousands of tons of stone have been quarried at Betchworth in benches or levels at different elevations, with the result that the present quarry face has a height of about 300 feet and a width of a quarter of a mile.

The feature of historical engineering interest previously referred to in connection with this establishment is the fact that, prior to the installation of the Ingersoll-Rand POV oil engine, the power necessary to drive the machinery was furnished by a steam engine operating with steam at a pressure of 400 pounds per square inch. This was a Perkins high-pressure compound steam engine. It was put in service in 1873 and was in regular use for a period of 46 years. It was built according to the patent of the late Loftus Perkins.

The boilers that generated this high-pressure steam are composed of heavy wrought-iron elements with welded ends—each tube being connected at each end by threaded wrought-iron nipples with left- and right-hand threads. Another interesting feature of this plant was the type of steam-pipe joint used. This was known as the Perkins joint and consisted of sockets having left- and right-hand threads so that the pipes screwed into the sockets had a metal-to-metal joint and were absolutely tight under even higher than operating pressures. The steam gage, still in position in the engine room, registers up to 1,000 pounds pressure, and the water gage is composed of strips of mica placed between heavy cast-iron plates. The level of the water could be seen because of a lamp placed behind the mica strips. This ingenious arrangement was necessary, as no glass tubes were at that date available to withstand those pressures.

The steam jackets around the high- and the low-pressure cylinders are composed of a continuous coil of heavy wrought-iron tubing cast in the respective cylinders and coupled direct to the boiler. The engine operated on distilled water; and no lubrication was used in the cylinders—the piston rings being composed of a special mixture known as Perkins metal. No oil therefore contaminated the condenser or feed water. A Perkins patent evaporator made up running losses in distilled water.

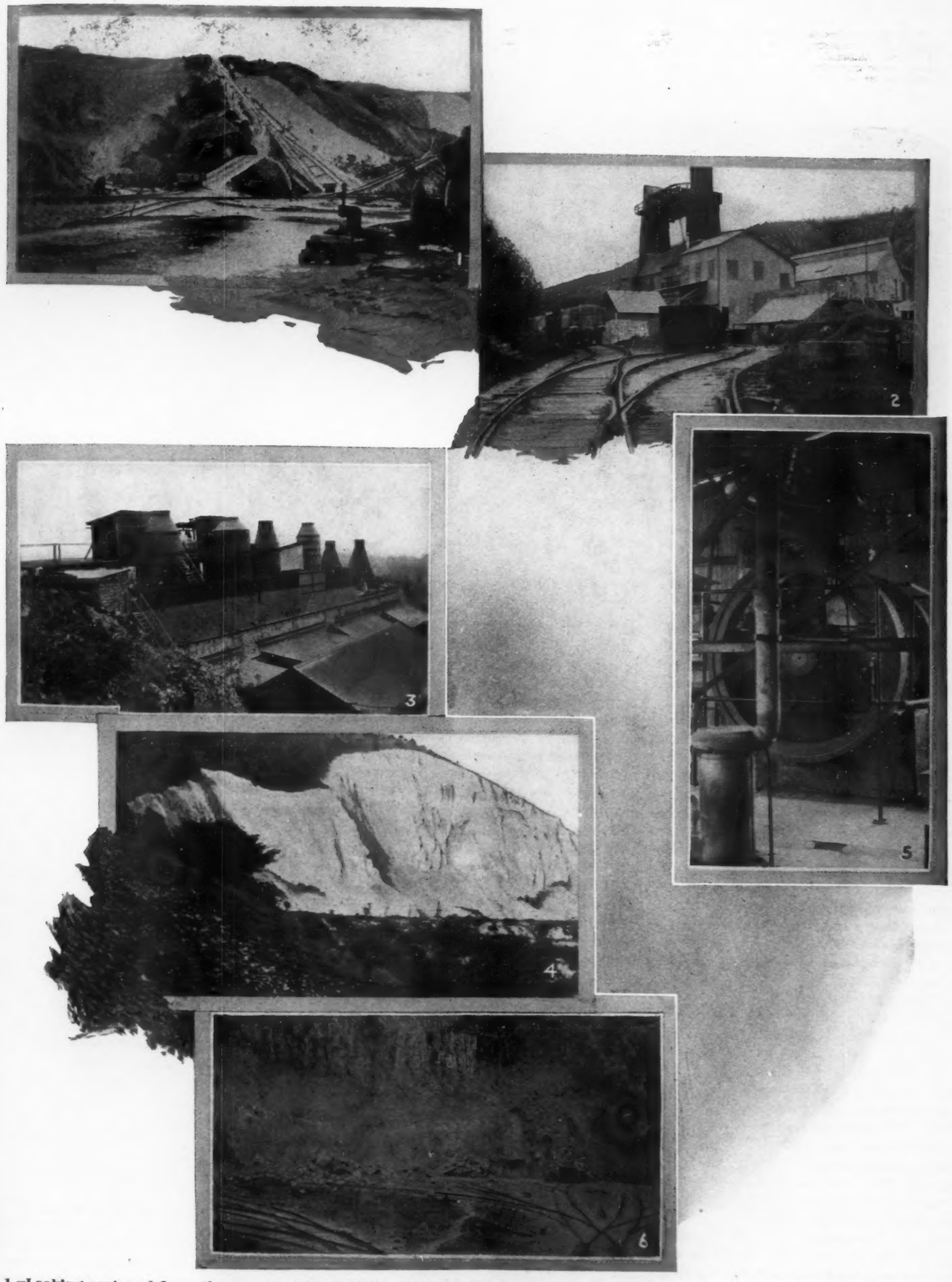
Engines of this type were installed in several places on land; and triple expansion units were aboard the yacht *Anthracite*, of 70 tons, which crossed the Atlantic Ocean in 1880. The engines had a high-pressure cylinder of 8-inch bore, an intermediate-pressure cylinder of 16 inches, and a 23-inch low-pressure cylinder—the stroke being 15 inches. Each engine developed approximately 81 hp.—the boiler pressure being 360 pounds. The coal consumption was 1.7 pounds per indicated horsepower per hour. The claims made for the Perkins' engine were: economy of fuel, reduction in weight and space occupied, and safety in operation.



Loftus Perkins' high-pressure, compound steam engine which was in regular use in the Dorking Greystone Lime Company's plant for 46 years.

Loftus Perkins, the inventor of this high-pressure steam engine, was the grandson of Jacob Perkins, a celebrated engineer and a pioneer in the industrial application of high-pressure steam. The latter was born in Newburyport, Mass., in 1766. Thinking that London would offer him greater scope for his efforts than the then youthful America he went to England in 1821, where he died in 1849 after a very successful career.

The writer wishes to express his indebtedness to the Junior Institution of Engineers, London, for some of the historic facts contained in this article.



1—Looking eastward from the quarry of the Dorking Greystone Lime Company, Ltd. 2—Dietzch kilns, with engine house containing oil-engine-compressor unit at the left. 3—Battery of kilns. 4—Another view of the quarry of the Dorking Greystone Lime Company, Ltd. 5—The POV-2 oil engine, the up-to-date power plant at the quarry. 6—This view of the quarry shows plainly the distinctive greystone strata.

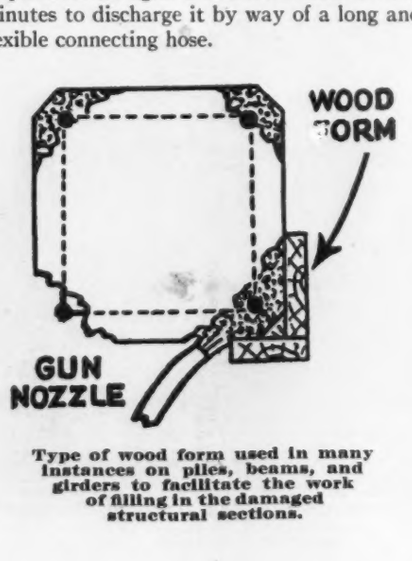
The air-operated concrete gun and how it was used to repair the substructure of the New York Municipal Baths at Coney Island. The air required to shoot the concrete in place was supplied by a portable compressor and piped for a distance of 100 feet to the point of application.

Pneumatically Applied Concrete Makes Damaged Foundations Good as New

GETTING ready for the bathing season in the case of the New York Municipal Baths, situated on the ocean front at Coney Island, necessitated more than the ordinary amount of work this year. It was found that exposure to the weather and the action of the salt water had damaged the reinforced-concrete foundation to such an extent during the past winter as to actually weaken the structure. Piles, beams, cross members and even the underside of the ground floor were in bad shape—the moisture having penetrated through to the steel reinforcing, causing it to rust and to expand and contract with the rise and fall in temperature. Big slabs of concrete, 2 inches and more in thickness, had thus been broken free from the reinforcing, leaving it exposed. In fact, much of the concrete was so disintegrated and fractured that it fell away when lightly tapped. Water seeping down from the bath houses overhead had contributed its share to the fairly extensive damage.

To assure the safety of the building it was essential that the bond between the old and the new material be a firm one. This, it was decided, could best be realized by applying the concrete pneumatically—that is, with air under pressure rather than by troweling because the latter method calls for the use of a wetter mixture than would have been desirable in this particular case. Concrete shot in place with compressed air, aside from the comparative ease with which the work can be done, is well compacted by reason of the force of the impact, which also has a tendency to bring to the surface much of the water contained in the mix.

All the patchwork was done by the aid of a Quigley concrete gun that is fitted with a ¾-inch pipe nozzle—the length of pipe being determined by the job in hand. The nozzle is slightly curved at the tip, has an elliptical outlet, and is devoid of valves—the flow of the material being controlled by the gun operator so that the man at the nozzle can give his entire attention to the applying of the concrete. The gun has a capacity of 2 cubic feet; and, in this instance, the mix consisted of Portland cement, sharp sand, ¼-inch grit, and just sufficient water to make a semi-plastic mix. After a batch of the proper quantity and proportions was mixed in an ordinary mortar box it took from four to five minutes to put it in the gun and another four or five minutes to discharge it by way of a long and flexible connecting hose.



Type of wood form used in many instances on piles, beams, and girders to facilitate the work of filling in the damaged structural sections.

Air at a pressure of from 80 to 90 pounds per square inch was used to do the concreting, the slender pipe nozzle making it possible to reach every nook and cranny and to fill up cracks as well as big gaping holes and surface irregularities without difficulty. The power or compressed air necessary to operate the gun was furnished by an Ingersoll-Rand 7x6-inch portable that was stationed more than 100 feet away from the point of use.

As illustrated by the accompanying diagram, a wood corner form was employed in repairing many of the piles, beams, and girders. This was made of 1-inch lumber and was secured by wiring or bracing—the mixture being shot in at an angle from one edge of the form. The concrete was applied in successive layers from ¾ inch to 1 inch thick, sufficient time being allowed to elapse between applications to give each layer a chance to partly set. In this way the damaged sections of the substructure were readily built up to the required line even though some of them were hard to get at. All the surfaces were then given a smooth finish with a mixture of cement and sand put on by trowel. The work was done by the Alliance Sand Blasting Company of New York City under the direction of Eugene Vogel.

The mileage of surfaced highways in Canada has been increased by 35 per cent during the past three years and is keeping pace with the steadily growing demands of motorists. At the present time there are approximately 65,000 miles of improved roads in the Dominion.

Temporary camp for the chicleros on a chicle plantation. It is open on all sides to the winds and to millions of mosquitoes.

Photos, © American Chicle Company

Making Chewing Gum for the Multitude

Something About the Origin of the Industry and the Methods Now Employed in Producing Gum of Many Kinds

By S. G. ROBERTS

"KEEP your whistle wet with a bit of gum! You know how well it does the trick."

The mere mention of chewing gum fills the mature mind with crowding recollections that range the whole gamut from the dusty ball field of the past, through later days of other strenuous sports, to the contemplative moments of the present—especially those moments when a bit of gum does much towards offsetting the discomfort of an overhearty meal. And all because of this wide experience we have come to recognize chewing gum as a veritable boon in many circumstances; and millions of us can bear testimony to the fact.

Admitting that the habit of chewing gum may have originated in America, and that because of the practice we were for years the target for the gibes of foreign critics, nevertheless there are many other countries that now offer lucrative markets to our manufacturers of chewing gums, and the greatest of these are the British Isles. Our exports of chewing gum now amount annually in value to approximately $2,000,000. Perhaps association with our fighting men during the World War had something to do with this. Be this as it may, chewing gum today is enjoyed abroad for substantially the same reasons that we turn to it here.

The Bureau of the Census, last year, issued a bulletin that disclosed the magnitude of our chewing-gum industry. The figures revealed that the value of the products turned out by 40 establishments in 1927 reached $62,001,320, and that 2,524 wage earners and a matter of 10,097 horsepower were required in the making of their several commodities. Surely, mastication *per se* has brought into being a very sizable business. Indeed, so the Bureau of the Census informs us, the chewing-gum industry—on the basis of value of products—ranks about 150th among the total of 340 lines of manufacturing endeavor covered by the census classifications.

There was a time when chewing gum meant either resinous nodules gathered from spruce trees or paraffin strips sweetened and flavored to satisfy different tastes. Today, most of the chewing gums made in the United States have chicle or kindred gums as their base—all these vegetable gums being somewhat elastic and decidedly ductile, and virtually insoluble in the mouth—thus serving admirably to carry flavorings and to stimulate the salivary glands through the process of mastication. Most of this chicle or natural gum comes from southern Mexico, British Honduras, and Guatemala.

Blocks of crude chicle on the way to the sea coast by the "fast freight" of the region.

Chicle is the solidified sap or latex of several kinds of sapodilla trees, which flourish in mahogany forests and on comparatively poor soils. The trees attain heights of from 30 to 40 feet, and the diameters of sapodillas of these sizes vary from 35 to 40 inches. To harvest chicle, the trunks of the trees are cut in zigzag lines extending from the base up to the first

Courtesy, Thomas F. Lee

Left—Chiclero cutting runways in a zapota tree for the sap. Right—Gourd attached at base of tree trunk to gather the exuding sap.

branches, and the latex flows into a perpendicular channel connecting with all the incisions. The cuts are made with a long and heavy blade, called a *machete*.

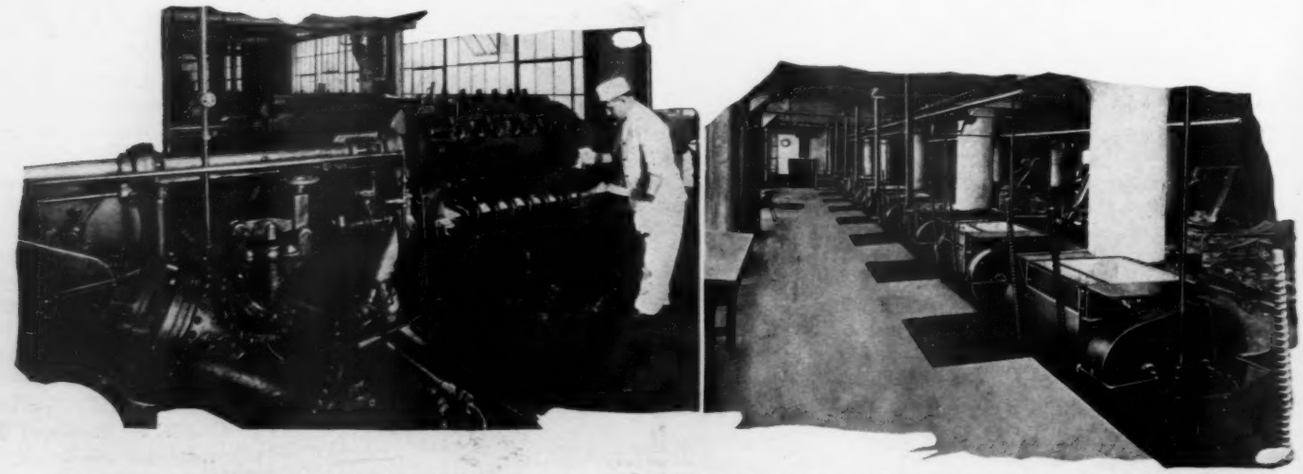
When the sap first exudes from the trees it is thin and white, but it soon thickens and becomes yellow and sticky. After the latex stops flowing into gourds, hung just above the ground on the tree trunks, it is collected by *chicleros* and carried to camps where it is heated until a test piece, taken from the boiling kettle, becomes hard on cooling. When sufficiently cool, the chicle is kneaded and formed into the blocks of commerce that weigh from 5 to 50 pounds each.

While there are several varieties of sapodilla trees, the best of the gum is obtained from a species known as the *achras zapota*, of which they are two kinds—the red and the white. The white variety is the largest producer of gum, averaging about 5 pounds of chicle a tree annually. Single trees in British Honduras have yielded as much as 25 pounds, and there is a record of 61 pounds for a tree in Mexico—these productions, however, are exceptional. When tapped conservatively so as not to injure or to kill the trees, each tree will give yearly anywhere from 2 to 4 pounds of gum. Most of the trees grow wild; and a good *chiclero* can collect and prepare between 250 and 300 pounds of chicle in the course of a month. Depending upon the quality of the gum, chicle brings from 50 cents to 80 cents a pound delivered in the Port of New York.

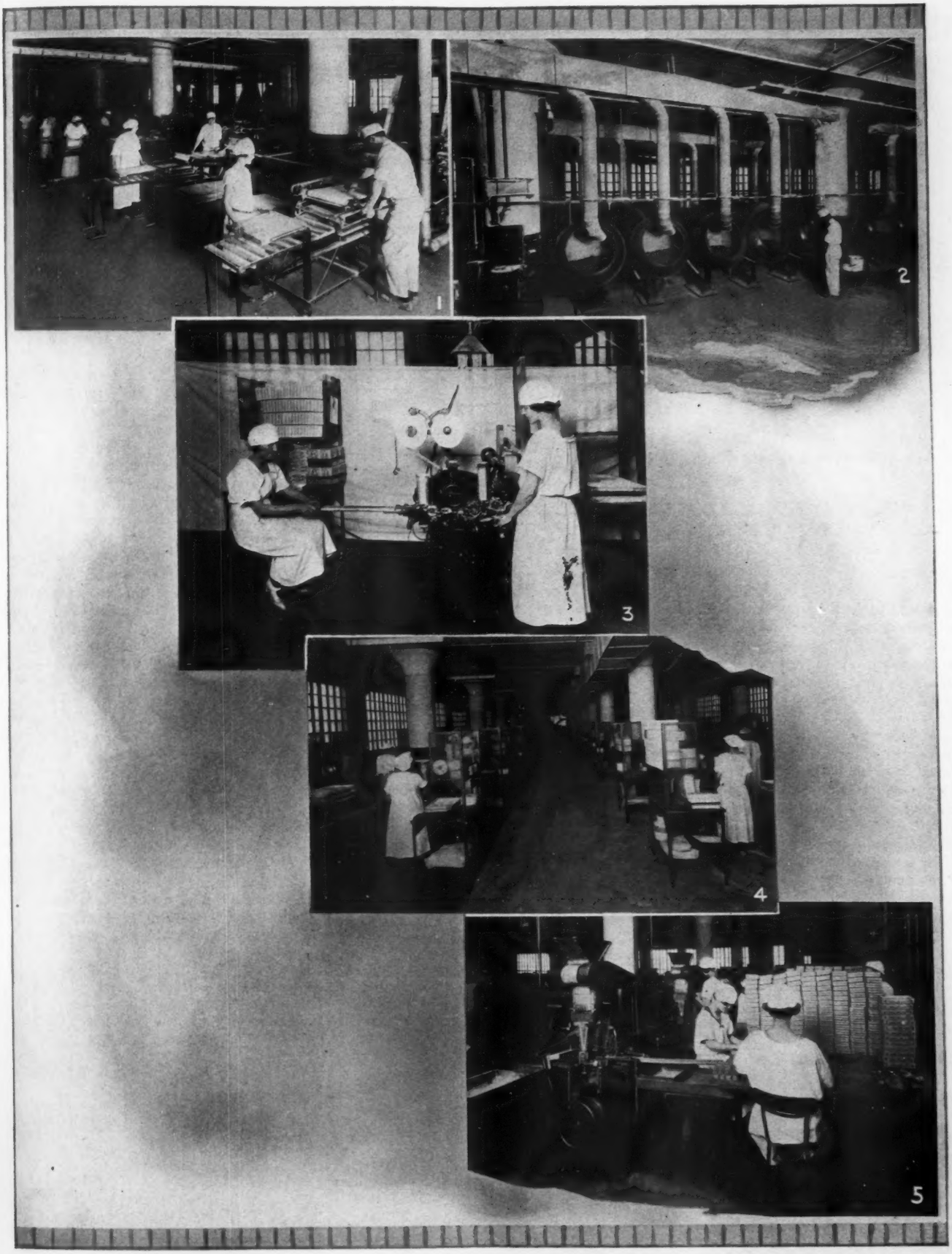
Before describing the processes by which the raw chicle is turned into palatable and pleasing forms of chewing gum, let us see how chicle was introduced into this country and first utilized in the manufacture of chewing gum. The story has to do with Thomas Adams and one Antonio Lopez de Santa Ana, a revolutionary Indian leader from Mexico, who found New York a healthier place for sojourning when there was a price on his head in his native land. This was before the Civil War; and Staten Island was the temporary abode of "General" Lopez.

Tradition has it that one evening while Mr. Adams and the General where conversing, the exile took a lump of gumlike substance from his pocket and, from time to time, broke off fragments which he chewed with manifest enjoyment—explaining that it was the dried sap of a tree native to Mexico and Guatemala. Chicle, the General called it. Examining a piece of the gum, it occurred to Mr. Adams that the substance might prove a good substitute for rubber. A little later he obtained a small shipment of chicle and began experimenting, but his labors were fruitless. However, recalling the evident pleasure General Lopez got from chewing the gum, Mr. Adams did likewise when his laboratory investigations failed, and the chicle tickled his palate. His sons tried it, too, and were equally pleased. The next step was to manipulate the stuff with a rolling pin in the home kitchen, and in that way plump chunks of chewing gum were produced. When these were first put on sale in a little shop in Jersey City they went like hot cakes, and the stock was sold out in less than an hour—the youngsters of the neighborhood clamoring for more. Thomas Adams was alive to his opportunity.

Taking his sons into partnership, Mr. Adams equipped a small plant in Brooklyn for the commercial manufacture of chewing gum; and that modest establishment laid the foundation for what has become one of America's sizable industries. Like all new ventures, the business had its setbacks and its difficulties, but the public steadfastly displayed a desire for the gum. After some years of unprofitable competition, various conflicting interests were harmonized; and the American Chicle Company is the present symbol ot this amalgamation and an outstanding indication of the magnitude of the chew-



Left—Powerful filter press which frees the melted chicle of all fibrous and other foreign solid matter. The melted chicle is flowing from eight faucets into a trough. Right—Battery of machines in which the purified chicle, sugar, and flavoring are mixed.



1—Rolling and scoring machines. 2—Chiclets receiving their final polish. 3—An automatic wrapping machine which envelopes each stick of flat gum with a jacket of tin foil or wax paper. 4—One of these wrapping machines will turn out 2,500 boxes a day—each box containing twenty packages of gum. 5—Machine engaged in boxing Chiclets. Each box holds five Chiclet nuggets.

Top—Chiclets being boxed by machine far faster than the work could possibly be done by hand. Bottom—The final stage of manufacture—inspecting and sealing of boxes to insure the maintenance of established high standards.

ing-gum business of today.

So much for the origin of chicle and the background of its adoption here as the principal basis of much of our chewing gum. Now let us see what takes place in making the raw commodity into the various tempting products so widely marketed. To this end, we shall make a visit to the great plant in Long Island City, N. Y., of the American Chicle Company, which turns out many millions of packages of different kinds of chewing gum every month in the year. Each gum is made agreeably to a precise formula, and every stage of production is under perfect control. Modern machines of many sorts are employed, and some of them are of a highly specialized character. Without these facilities and these methods it would be quite impossible to give the public the commodities of unfailing excellence and uniformity to which it is accustomed.

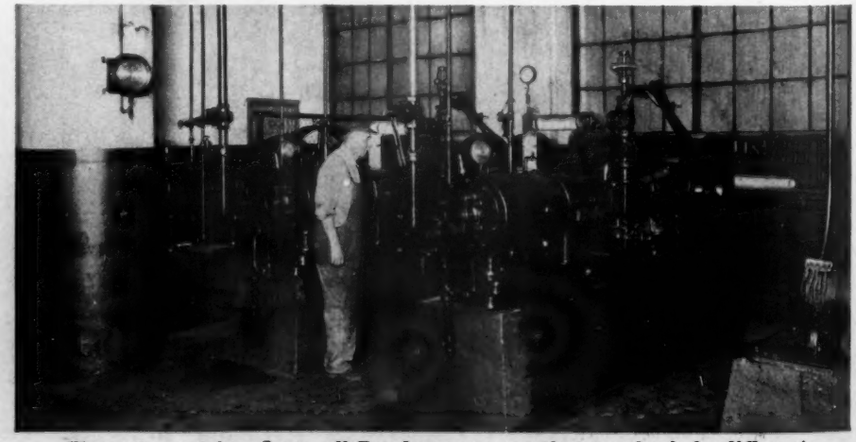
While chicle is the principal base for certain of the chewing gums made in the Long Island City plant, still other of the gums are compounded of several vegetable gums, and these blends are designated by the term "chicco". In either case, the gums arrive at the plant in a raw state, and must be ground to a crumb-like condition, washed, and then dried and seasoned in a drying room for a period of about 48 hours. Chicle, for instance, contains from 25 to 30 per cent of moisture in the raw state, and the drying process cuts this down to somewhere around 4 to 6 per cent. The atmosphere of the drying room is kept at a constant temperature and a given relative humidity by an air-conditioning plant, the essential valves of which are automatically actuated with compressed air.

Whether the gum be chicle or chicco the crumby material next goes to an enclosed steam-jacketed kettle in which it is heated until it will flow readily. When fluid, it is forced onward to a nearby large and powerful filter press by air at a pressure of 200 pounds—the air pressure being applied to the free surface of the molten gum. The gum is thus driven from the kettle and through a series of interposed screen sections. The filter is composed of eight sections, each of which is equipped with two screens. Hydraulic pressure keeps the several sections of the press airtight. The steam-jacketed kettle is fitted with mechanically operated paddles that thoroughly agitate the gum. The filter press removes all fibrous material originally carried by the raw gum. The cleansed gum, on leaving the filter press, flows by gravity to steam-jacketed mixing kettles located on the floor below. While the gum is in the mixing kettles flavoring and sugar are added to suit the particular commodity that is to be produced from it. One of our illustrations shows a whole battery of these mixers. No stage in the making of chewing gum is more important, because the flavoring introduced there plays so big a part in insuring popularity. Many and varied are the extracts and the essential oils utilized so that the young, the middle-aged, and the mature can have the flavoring that most appeals to each.

From the mixing kettles the gum goes to mechanical kneaders—substantially like the dough-kneading machines in steam bakeries, and these work upon the sweetened and flavored gum until it is as smooth as cream. From this point on the succeeding operations consist in the main in giving the gum the convenient marketable forms of strips, balls, and rectangular lozenges; of coating and polishing the balls and lozenges; and then of wrapping and packing the various kinds for convenient handling and selling.

The gum on leaving a kneader is squeezed out like a monster ribbon of toothpaste to be gradually reduced in size as it is carried on a sugared belt conveyor through a series of roll presses from which it issues as an endless scored sheet—the scoring running at right angles so as to facilitate later the breaking of the ribbon into the familiar strips of package gum. The sheets or ribbons, in suitable lengths, are laid on trays and cooled for 24 hours in a room where the air is conditioned automatically. The sheets that are scored are fed, when properly cooled, to machines that break the gum apart and wrap the strips. When wrapped, the flat gum is put up in containers holding twenty packages—each package consisting of five pieces of gum. The nimble-fingered girls who do the packing fill anywhere from 1,000 to 1,200 boxes a day.

The ball gums are first fashioned into pencils or rods that are run through other rolls for molding into ball centers that are then coated and colored. The coating is done in revolving cans into which conditioned air is blown continuously to promote drying. An attendant pours, from time to time, just so much coating fluid into each can, and this is taken up progressively by the ceaselessly moving balls. When they have acquired sufficient coating, the balls are removed from the cans and placed in polishing pans. The object of the polishing is to make the balls

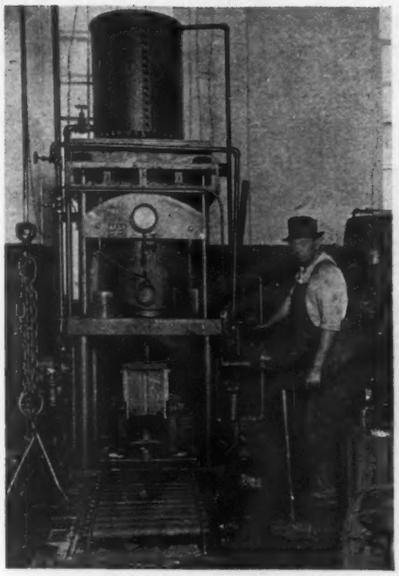


Three steam-driven Ingersoll-Rand compressors that supply air for different purposes in the Long Island City plant of the American Chicle Company.

more appealing to the eye and to render them less likely to be affected by exposure to the atmosphere. The pans used for this purpose are lined with a waxlike mixture, and the balls pick up some of this compound as they come repeatedly in contact with a pan's inner surface. The white and shiny rectangular Chiclets are similarly coated and polished. The balls and the Chiclets are also packed by machine, as is the case with the flat gums. All told, there are manufactured in the Long Island City plant more than twenty different products. Among these are Adams Pepsin-Mint, Beeman's Pepsin, Yucatan, Black Jack, California Fruit, Dentyne, Peptyne, Ball Gum, Chiclets, and others.

The personnel of the plant numbers in the neighborhood of 500; and everything is done to insure healthful and thoroughly sanitary working conditions. Cleanliness is insisted upon everywhere throughout the factory. In many departments of the great 5-storied structure it is necessary to maintain a temperature of 70°F. the year round; and in warm weather the air is cooled by a number of ammonia compressors before going to the air-conditioning apparatus that controls the atmosphere in the plant. Besides the uses for compressed air already mentioned, it is employed at frequent intervals to blow clean the scores of electric motors utilized throughout the establishment to drive different machines. This air is furnished by three compressors—two NF-2's and one NE-2.

The American Chicle Company is insistent upon purity and high standard in the gums and all other ingredients entering into the company's several products; and none of these can be used in production until after it has been subjected to laboratory test. Recalling the extremely modest way in which Thomas Adams began making chewing gum from chicle, a visit to the plant in Long Island City is at once a revelation in manufacturing progress and of the reasons underlying the popularity of the commodities made there. The company also operates factories in San Francisco, Calif., Toronto, Canada, and Mexico City.



Courtesy, Railway Mechanical Engineer

A turn of the air valve under the operator's hand is all that is required to feed this hydraulic press used to apply and to remove driving-box crown brasses.

AIR-OPERATED FEEDER FOR HYDRAULIC PRESS

THE special feature of the hydraulic press shown in the accompanying illustration is an air-operated self-loading mechanism. The press is installed in a railroad repair shop where it serves to apply and to remove driving box crown brasses. To help the workman get the fairly heavy boxes in and out of the press and, incidentally, to save time, it was equipped with a self-feeder consisting essentially of a freight-car air-brake cylinder. This is located back of the machine and is connected by means of the piston rod to a plate that is moved back and forth under the ram, depending upon the stroke of the piston.

Each driving box as it comes along is placed on a roller conveyor, on the floor in front of the press, by the aid of a pair of tongs and an air hoist, after which it is shoved on to the plate—the action of the piston carrying the work under the ram or out from under, as the case may be. In removing crown brasses, the boxes, in turn, are put on top of a U-shaped filler block, as is commonly done. The released brass falls on to the plate and is pushed clear of the machine and then on to the roller conveyor. Thus the press is fed without manual effort on the operator's part other than the manipulating of a valve within easy reach of his hand. Compressed air is also used to raise the main-cylinder piston of the press—hydraulic pressure effecting the down stroke.

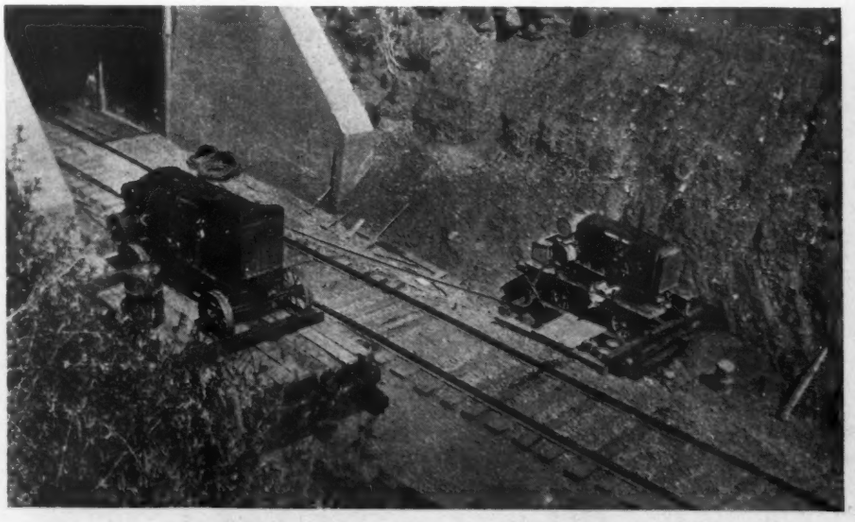
According to a recent survey, eighteen railroads in the United States that were once entirely steam operated now have under electrification more than 4,300 miles of trackage, or 1,900 miles of roadway, which is for the most part embraced within their main-line systems. Definitely authorized programs of expansion, says the survey, will within five or six years almost double the present electrified mileage.

PNEUMATIC EQUIPMENT HASTENS TUNNEL-DRAINAGE JOB

CONFRONTED with the necessity of providing drainage facilities for a tunnel on their Great Falls-Billings branch, the Great Northern Railway recently found it advisable to lay 10-inch drain tiles throughout the length of the tunnel.

In the eastern end of the tunnel, where the rock consisted chiefly of shale, concrete slabs 4 feet wide and 14 inches thick were placed at 30-foot intervals from wall to wall so as to prevent the sides from caving in when excavating for the tiles. Throughout this stretch of soft ground ditching was done by Ingersoll-Rand tie tampers equipped with chisels. With their aid this part of the job was completed rapidly. Working westward the going became harder, and a longer stretch of solid sandstone was encountered. There the men had to employ "Jackhamers" to drill vertical holes 2 or 3 inches apart, breaking up the intervening rock with sledge hammers and track chisels.

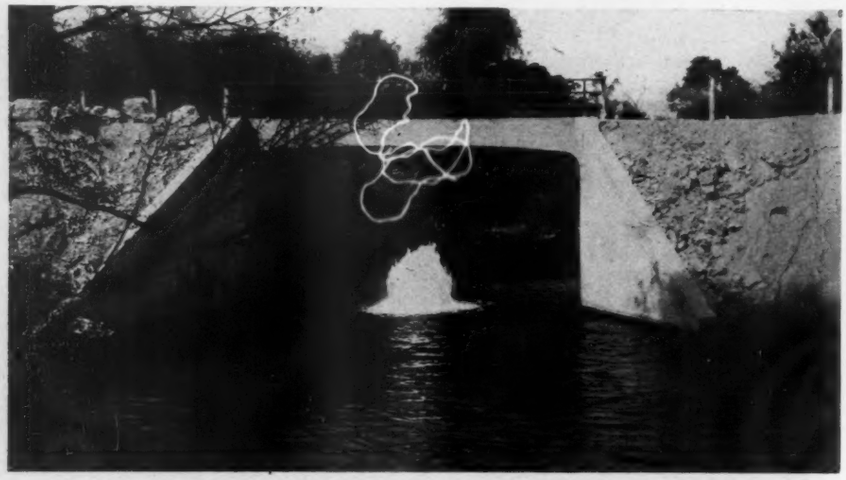
The tunnel has a length of 1,500 feet; and about 1,200 cubic yards of dirt and rock were removed in laying the drainage tiles. To complete the excavating required 35 days' time and a crew of fifteen men, seven of whom operated the compressed-air tools. The air for the "Jackhamers" and the tie tampers was supplied by two portables—one 10x8-inch compressor producing air at 100 pounds pressure and a smaller machine furnishing air at 90 pounds pressure. Both compressors were installed at the east portal—the air being fed through piping laid the length of the tunnel. Even so, the pressure was at all times sufficient to drive the tools. One man was able to take care of both portables.



The compressor plant in the form of two portables that was rigged up at the eastern portal of the tunnel to furnish air for the "Jackhamers" and chisel-equipped tie tampers that did the excavating for the drainage system.

AIR LIFT AUGMENTS STREAM FLOW

IN Brackenridge Park, San Antonio, Tex., there is a small lake in the center of which crystal-clear water gushes forth day and night and feeds a stream that meanders through the park and finds use in a swimming pool and various ponds. To all appearances this surge of water is due entirely to natural forces, and few of the hundreds of thousands of persons who visit the park each year realize that a small wooden structure, a few feet back from the water's edge, has anything to do with its steady flow. In reality, the structure houses an air compressor which supplies the energy responsible for raising a goodly portion of the water to the surface.



This diminutive geyser is caused by an air lift that has been installed in the center of the lake to increase the flow of water.

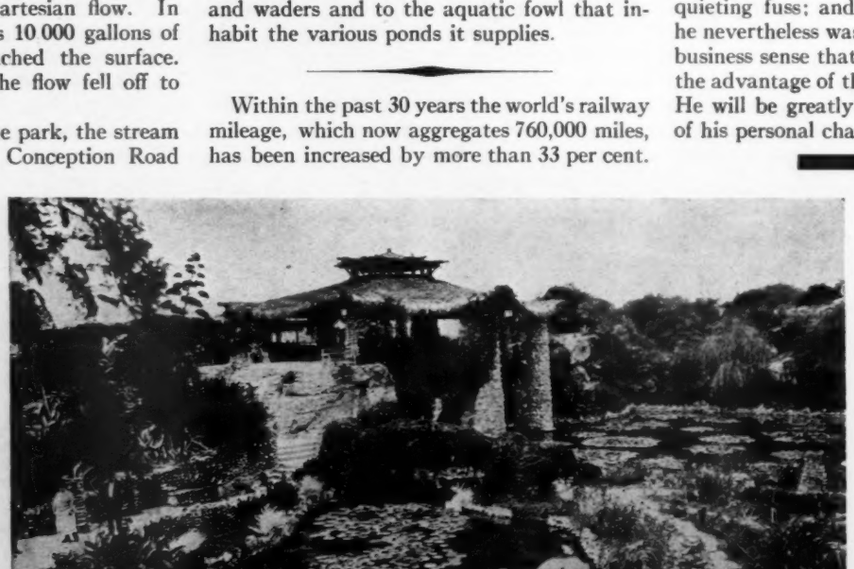
Originally, a well 15 inches in diameter was drilled by the city to a depth of 700 feet, where it struck a strong artesian flow. In the wintertime as much as 10 000 gallons of water a minute thus reached the surface. Each summer, however, the flow fell off to practically nothing.

After passing through the park, the stream eventually flows past the Conception Road generating station of the San Antonio Public Service Company. This company desired to use the water for its condensers, but the seasonal fluctuation in flow did not fit in with the plan. To remedy the situation, the power company entered into an agreement with the city whereby the former was to purchase and to install suitable equipment to augment the natural flow of the well by pumping. To this end, various types of pumps were investigated, and the air-lift method was decided upon because of its simplicity and dependability.

A 10-inch pipe was run down the well for 90 feet and a 2-inch air line, of approximately the same length, placed within it. To furnish the required air a Class ER-1 compressor, belt driven from a motor, was housed in the building already referred to and which is just large enough to accommodate it. The compressor operates at 37 pounds discharge pressure, and, upon test, the equipment was found to increase the flow of the well during the low-flow period from well-nigh zero to 3,000 gallons per minute. The unit requires no attendant. Therefore it is only natural that sight-seers should assume the flow of the well to be entirely natural.

The well adds a picturesque touch to the many attractions of the park; and the water that comes from it is a never-ending source of delight to the younger generation of bathers and waders and to the aquatic fowl that inhabit the various ponds it supplies.

Within the past 30 years the world's railway mileage, which now aggregates 760,000 miles, has been increased by more than 33 per cent.



© H. L. Summerville

Picturesque sunken gardens in Brackenridge Park.

JOHN WILLIAM MALLER

IT is with profound regret that we announce the death, on June 2, of Mr. John William Maller, head of the Export Department of the Ingersoll-Rand Company. His passing is a distinct loss to the organization in which he stood forth as well as to the host of friends he made during his service with the company over a period of nearly fourteen years.

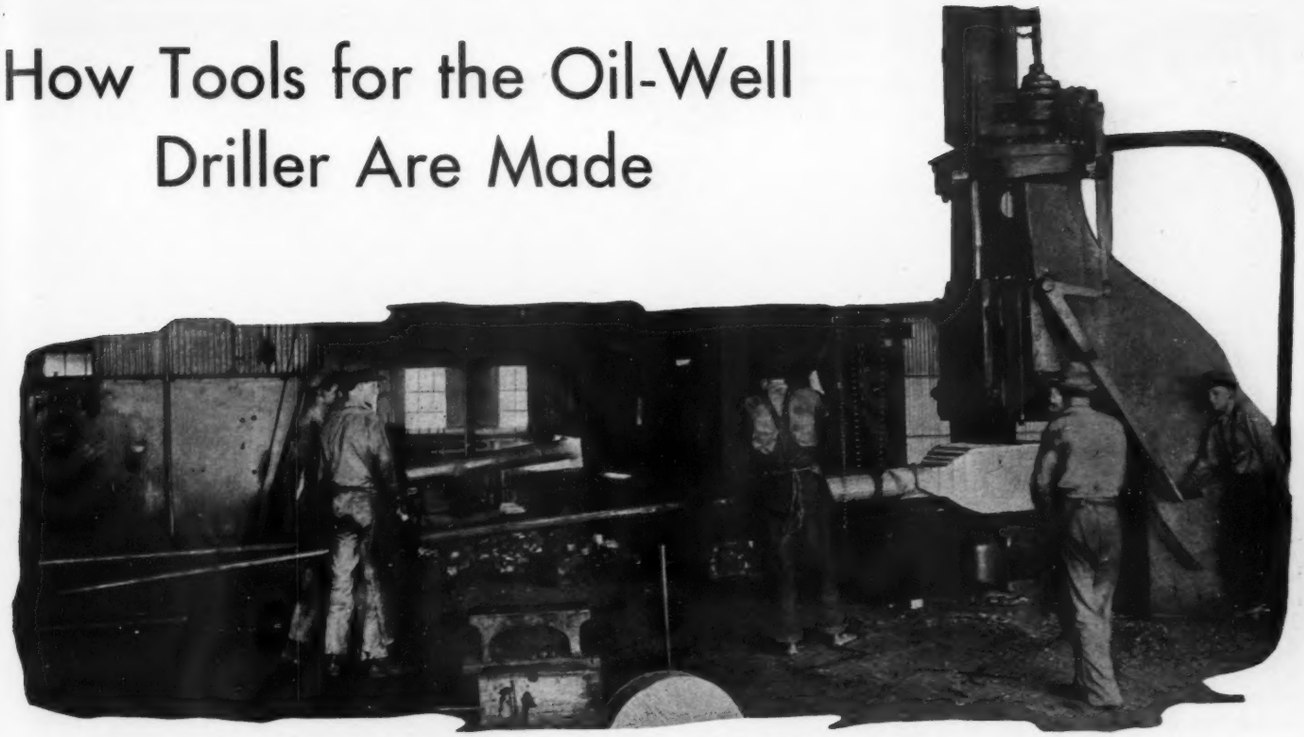
Mr. Maller was born in Rumania in 1887, but he came to America as a youngster—being brought up in New York City where he went to school and afterwards was graduated from the School of Mines of Columbia University. From the time he was sixteen years old he was self-supporting; and the progress he made was due to his sterling qualities, which were many.

Before entering the service of the Ingersoll-Rand Company, in 1916, Mr. Maller had been identified with mining enterprises in the United States and in Mexico and Central America. He had a command of Spanish, French, and German, which added to his fitness for work abroad. This proved especially true when he was detailed to South America where, in 1919, he was made manager of the Ingersoll-Rand Company's office in Lima, Peru. In 1922, he was transferred to Calcutta, where he became the managing director of Ingersoll-Rand (India) Ltd. Last December he returned to the United States to assume the managership of the Export Department at the head offices in New York City of the Ingersoll-Rand Company.

John William Maller made and held his numerous friends because of his kindly and considerate disposition. He had a poise and evenness of temperament that made it possible for him to accomplish much without disquieting fuss; and while bland and obliging he nevertheless was always possessed of a true business sense that he exercised unfailingly to the advantage of the company he represented. He will be greatly missed, and most because of his personal charm.

A very practical garment has been made a part of the regulation outfit of the flying branch of the Ontario Forestry Department. It is a self-inflating rubber vest that is primarily a life saver, although it also serves to keep the pilots warm. At the lower right-hand edge of the garment is a clip which, in case of emergency, is made to release a charge of compressed air stored in a small cartridge. The vest is distended almost immediately with sufficient air to keep a load of 300 pounds afloat indefinitely.

How Tools for the Oil-Well Driller Are Made



Forging a large piece of steel while another one is being heated in the furnace in the background.

By C. H. VIVIAN

THE watchword of the oil fields is speed. The very nature of the business of producing petroleum makes speed of vital importance. Rare, indeed, is the oil field that is operated by a single company. The large producers all have scouts whose business it is to keep track of and to report upon the activities of other companies, particularly the activities of their geological and land staffs.

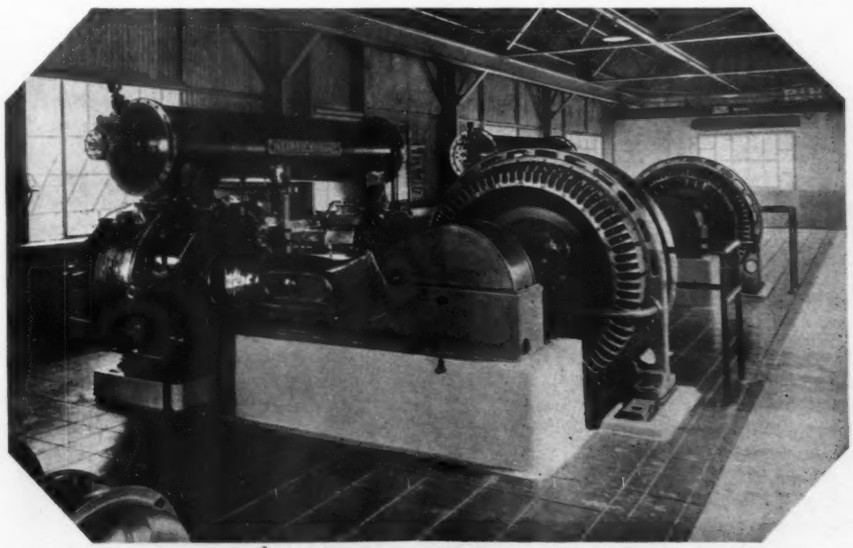
Once a company has received a favorable report on the geology of an area and decides to drill, it starts gathering leases from the property owners of the land involved. Right there other companies step in and start acquiring leases also. By the time the "wildcat," or test well, is under way, from two to twenty or more interests are represented. The first on the ground naturally get the cream. The late comers take what is left—"outside" acreage which, according to the geologists' calculations, is more than likely "off the structure." But geologists are not given the power to look into the ground, and many, many instances are on record where fields have been extended by subsequent drilling until so-called outside tracts have proved to be within the productive area.

If, then, the wildcat well strikes oil—and this is a big "if," because in 1928 a matter of 7,200 out of 22,331 wells drilled were dry holes or "dusters"—every company that holds a lease is a potential owner of the oil that lies beneath the ground. But, to get at their share, all must put down wells. Moreover, since the oil is trapped in porous rock under pressure and will naturally migrate toward the point where that rock has been punctured and the pressure relieved, it behooves every leaseholder to put down wells before one or more of his neighbors start drawing oil from beneath his ground.

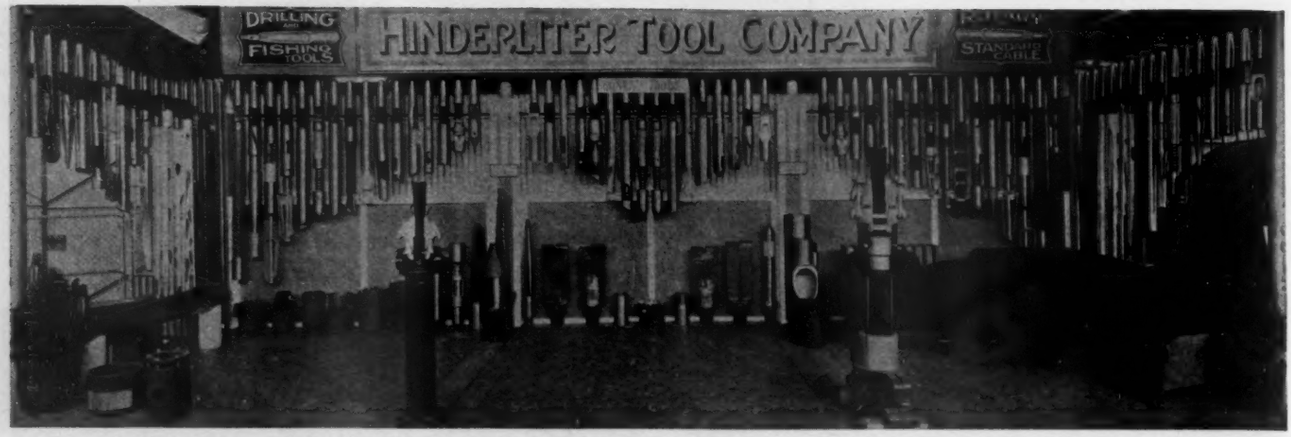
So, speed is the watchword of the oil fields. Heavy machinery is moved in without stopping to build roads, and drilling rigs rise as though by magic. The tools start biting away at the ground, racing toward the liquid wealth below. Work goes on 24 hours a day, usually in two shifts, or tours.

Thus it goes throughout the producing end of the oil industry. Things move at full tilt all the way down the line. Slow methods are discarded as soon as faster ones appear. Equipment that will not stand up to the pace is fed to the scrap heap if something better is available. To spend hours fixing and repairing simply is not countenanced.

The foregoing brief sketch will perhaps serve to make it clear that the success of those concerns that manufacture machines and materials for use in oil fields is measureable by these factors: their ability to provide something that will exactly meet the needs and that will stand up well in service, and their ability to have their products ready for loading out in a hurry so that no time will be lost in putting them to work. The last point is of more relative importance than the others. The oil fields will excuse breakage as inevitable, but only if replacements for repairs are speedily available. An experienced supply house knows it is a waste of words to ask an oil



These two Class PRE-2 compressors furnish air for operating the forging hammers and for other uses about the plant.



A display of the Hinderliter line at the International Petroleum Exposition held a while back in Tulsa, Okla.

man when he wants something he has ordered. Nine times out of ten his reply would be, "Yesterday".

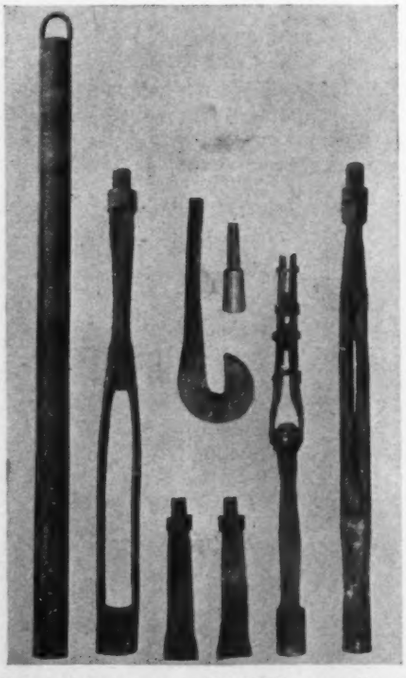
What has been written thus far is by way of explaining, in part at least, why the Hinderliter Tool Company of Tulsa, Okla., has been able to build up, within the span of one decade, a business that is known and patronized wherever petroleum is produced. The business of this firm is the manufacture and sale of drilling and fishing tools for the rotary and standard cable tool processes. The company has grown up largely around its vice-president and general manager, Frank J. Hinderliter. It makes more than 30 tools that have been invented by Mr. Hinderliter and protected by patents, as well as a line of standard competitive tools. Starting in 1919 with a capitalization of $300,000 and a factory that had previously been used for other lines of endeavor, it now is capitalized at $1,200,000 and occupies a new, model plant in addition to the old one.

Fishing, as applied to drilling oil wells, is not unlike the better-known kind, and pretty much the same sort of gambling proposition. In drilling—whether it be with cable tools that move up and down and strike chisel-like blows upon the bottom of the hole, or with rotary tools that burrow into the earth by a continual turning of the bit—it not infrequently happens that the suspended tools become broken off or disconnected from the "string" and are lost in the hole. Efforts at their recovery constitute a fishing job. Sometimes weeks are spent before success comes. Sometimes repeated efforts fail, and the hole has to be abandoned even though it may represent an outlay of $50,000 or more.

It requires no familiarity with oil-well-drilling technique to realize that there is need here for many special tools. It is in providing them that the Hinderliter Tool Company has been the leader. How this came about can best be told in the words of H. B. Hendershot, secretary and assistant treasurer of the company: "The eld-time driller was a very capable man. If there was a fishing job to be done, he sized up conditions and figured out which available tools would probably be required. He ordered these tools by name from the nearest supply house. But with the coming of the World War, and a coincidental vast increase in drilling, conditions changed. Less experienced men were in charge of many operations. When something was lost in a well, they would call up a supply house, describe conditions as best they could, and ask for advice regarding suitable tools to fish with.

"Right here was where the Hinderliter Tool Company stepped in. We made a study of the fishing problem. We developed additional special tools as need for them arose, and even anticipated needs. We were ready to prescribe for the fellow who told us his troubles and wanted to know what to do and what to do it with. You might say that we became doctors for sick oil wells.

"Before long drillers came to look to Hinderliter for help when they had a fishing job. We established stores—of which we now have fourteen in the states of Kansas, Oklahoma, Texas, and New Mexico—where the tools were always in stock, and where we could effectively service the tools we had out. We opened branch offices in foreign countries, with competent men in charge. We distributed our products through supply houses. Having done all these things, we naturally got plenty of business."



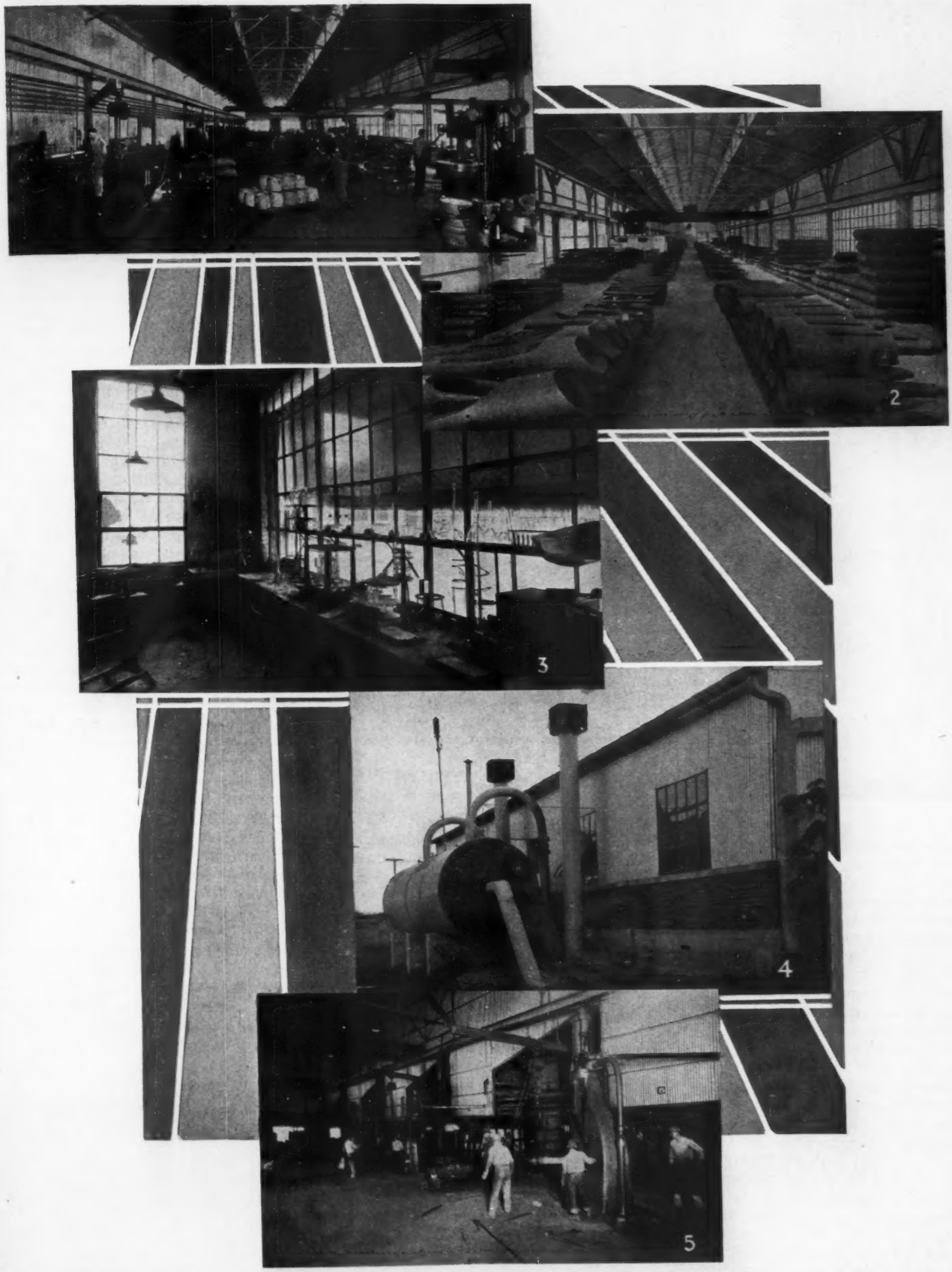
These tools were used in drilling an oil well in West Virginia in 1859, and were made by Bernard O'Neil with a hammer and a cold chisel. They are now on display in the Hinderliter Tool Company's office, where they offer a striking contrast to the present-day tools.

The concern has gone on and is still going on developing along the same lines. It is today the only known manufacturing establishment that devotes its entire facilities to the making of drilling and fishing tools. New tools are continually being added and old ones improved upon. No royalty is charged on any of these patented tools. The evident aim is to produce good tools, priced as reasonably as possible. On more than one occasion the company has brought out a patented device that did some particular piece of work better than the tools previously available therefor and which sold for from 10 to 20 per cent less.

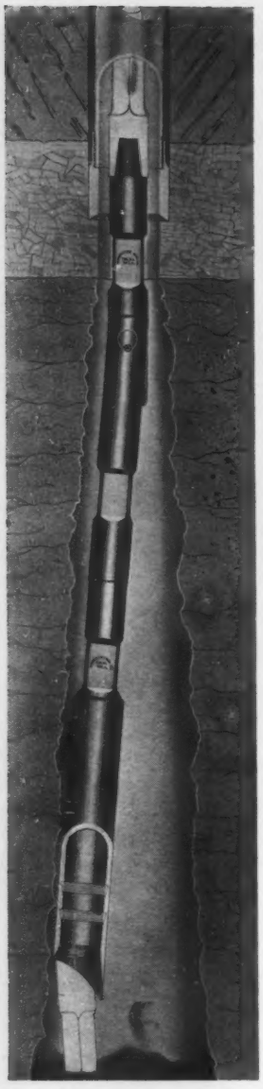
Oilmen hail some of Mr. Hinderliter's inventions as the greatest time-and-money savers at their command. His father before him was an oilman, and he received training in feld work and in machine-shop practice in his younger days. With Mr. Hendershot and A. G. Lott, now in charge of the new plant, he spent a number of years in the service of one of the large oil-field supply houses. Thus, his knowledge of the industry and its needs is thorough, and he keeps it up to date.

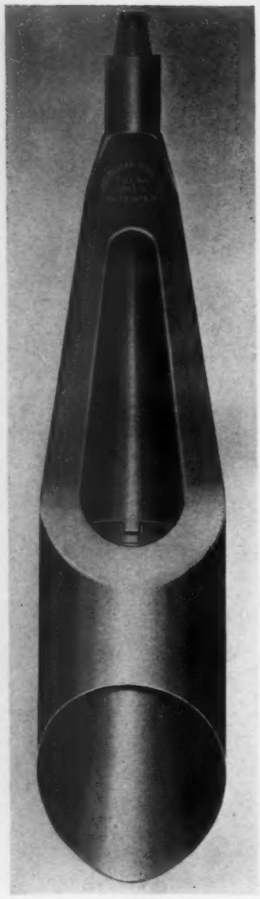
The other side of the company's success is found in its manufacturing methods and its business policies. It features "Honest Tools" in its advertising, and welcomes visitors to its plant to see how they are made. The Hinderliter Company has never sued a customer for non-payment of a bill. Anyone who tries its tools and then claims they are no good is not obligated to pay for them.

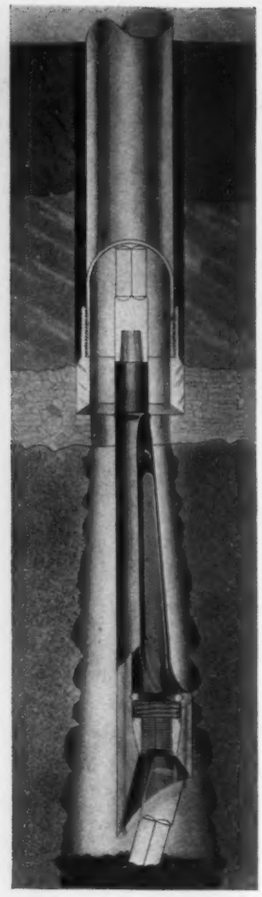
The new plant, occupied in 1927, is a model of cleanliness and orderliness. The company heads say it costs no more to keep a plant clean than it does to run it dirty, and they insist that everything be always ship-shape. Consequently, the plant is at all times ready for inspection. The compressor room is immaculate, and is a model of its kind in the country. One of the accompanying illustrations gives an idea of its appearance. One feature is worthy of note. When the compressor foundations were built, wires were run through them to provide electrical outlets at the crankcase erd for plugging in extension



1—Commodious and well-lighted shop of the Hinderliter Tool Company. 2—The storeroom, where every conceivable kind of oil-well drilling and fishing tool is kept in stock. 3—A corner of the laboratory which is an essential aid in turning out satisfactory tools. 4—Rear of the compressor plant showing the large outdoor air receiver. The compressor intake pipes are equipped with Reed air filters. 5—A section of the forge room which is provided with six air-operated hammers having a total falling weight of 10,350 pounds. A 3,400-pound hammer is standing in the foreground.



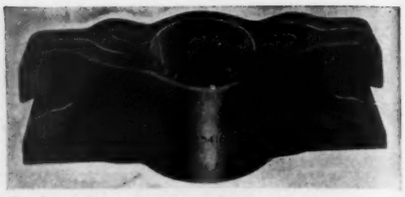




Left—How the Hinderliter kick-off tool may be manipulated at a well bottom to recover a lost tool leaning against one side of the hole.

Center—The Hinderliter eccentric combination socket, which has been termed one of the most valuable fishing tools ever invented.

Right—Sketch showing how the socket recovers lost tools in a well.



Casing ring and wedger designed for lowering, pulling, and holding a long string of casing or pipe in a well.

cords. This not only facilitates working around the machines but also allows overhead lights to remain on and untouched during such work.

There are two duplicate compressor units, with space provided in the building for additional machines when they become necessary. Those installed are Ingersoll-Rand Class PRE-2's, each of 1,574 cubic feet piston displacement per minute and having 5-step clearance-control regulation. They are driven by synchronous motors, each of which has its separate motor-generator exciter.

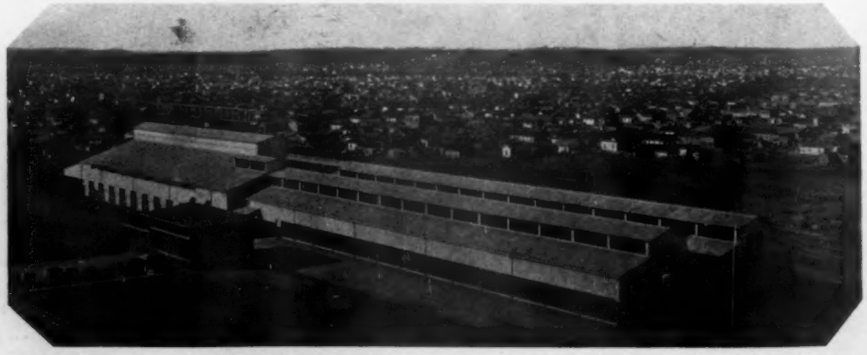
Essentially, all Hinderliter tools are forged steel. There are six forging hammers, ranging in size from 800 pounds to 3,400 pounds, and all in one room. An 8,000-pound hammer is being added. Forgings range up to 4,000 pounds in weight. Both oil- and gas-fired furnaces are used for heating, and are fitted with complete automatic control.

The principal use for compressed air is for operating the hammers. Prior to the construction of the new plant steam was used for this purpose. Air is found more satisfactory. Some of the reasons for this were outlined by the plant manager, Mr. Lott, as follows: "The dripping of moisture from condensed steam at the hammers is eliminated. Air is not as loggy as steam. It gives a quicker action and seems to strike a harder blow, even though the air pressure used is from 90 to 95 pounds, as compared with 100 to 110 pounds of steam formerly employed. It is unnecessary to keep the hammer in action to 'warm it up.' We can have 100 pounds of air available in from five to ten minutes. To have sufficient steam pressure available requires a fire under the boilers some hours beforehand. In addition to the foregoing facts, we have found that the men operating the hammers prefer air to steam."

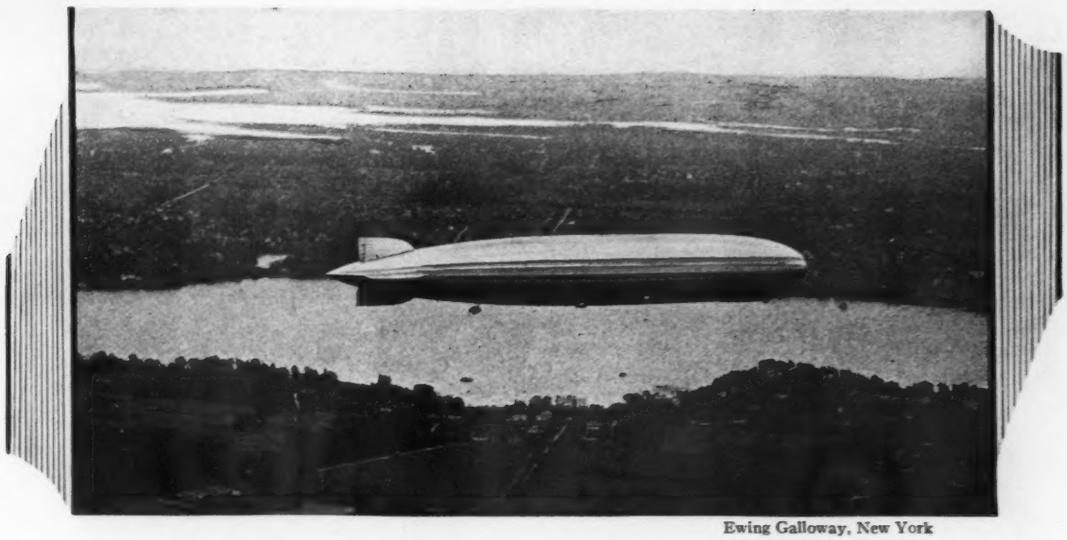
The success of the Hinderliter plant with air forging has been increased by an air-piping system designed especially for the work intended. The compressors discharge outside the building into a horizontal receiver, 6 feet in diameter and 24 feet long. A moisture trap is provided there. The air line from this receiver to the forge room consists of 130 feet of 12-inch pipe. Within the shop is 120 feet of overhead 20-inch line with a moisture trap at either end. Off this runs approximately 200 feet of 6-inch line. All this pipe is welded, eliminating leakage. Air for each hammer is taken from the top of the feeder line, which, together with the adequate provision of traps and the large reservoir capacity in lines and receiver, insures that no perceptible moisture reaches the hammers. The large reservoir capacity also serves as air storage sufficient to take care of heavy demands. Ordinarily only one compressor has to be operated, the machines being run alternately, each a week at a time.

A modern heat-treating department is adjacent to the forge room. Compressed air is used there for agitating quenching oil. A laboratory is maintained for running metallurgical tests on all steel used. Fishing tools are mostly made from steel having a high carbon content. Drilling bits, tool joints, and drill collars are made from alloy steels, such as manganese and chrome-nickel. Bits and certain other tools are treated with special hardening materials to increase their resistance to wear. The rough forgings pass to a completely equipped machine shop. In line with the policy of cleanliness, there is compressed air available at each machine for blowing off metal turnings and fragments.

The old plant of the company is now given over to stock for rent and to shops for the repair of tools, pumps, engines, and other oil-field equipment. It also houses the general offices of the firm.



The new plant of the Hinderliter Tool Company where all operations are carried on under one roof. The small structure at the left is the office building.



"Graf Zeppelin" [aloft on flight] between New York City] and Lakehurst, N. J.

Ewing Galloway, New York

"Graf Zeppelin" Uses American Gas For Long Flights

Pyrofax, Prepared Primarily for Household Use, Supplies Motive Energy to the Airship's Motors and Widens Her Radius of Action

By A. S. TAYLOR

ONCE around the world: seven times across the Atlantic! This, in brief, sums up what the *Graf Zeppelin* has done since she began her active commercial career in 1928.

In that interval she has journeyed nearly 69,000 miles and has revealed capabilities that have refuted a legion of "Doubting Thomases." On her epochal voyages she has held surprisingly close to the schedules prescribed notwithstanding the fact that wind and weather were far from favorable on a number of occasions. Indeed, her performances have been so fine that the public at large has accepted them as matters of course. This is regrettable, because it has lessened a broad understanding of what the craft really represents in the way of an advance.

Twenty-one years ago on August 29 coming, a Zeppelin sailed over Berlin for the first time and landed at the suburban town of Tegel, where she was greeted with tumultuous acclaim. At that time the trip from the place of building on the shores of Lake Constance to the German capital was a long and somewhat venturesome one. How many of us are aware of what has been done since 1909 to make the present *Graf Zeppelin* possible? Between that memorable occasion and the summer of 1914, German airships of Count Zeppelin's design acquired a measure of commercial significance, voyaging to and fro along certain routes within Germany; and the six airships owned by the operating company had carried the while 37,000 passengers and had flown an aggregate of 90,000 miles.

The work done by that fleet was highly creditable, and especially so in view of the obstacles that had to be overcome and when making due allowance for the essentially pioneer character of the undertaking. The aim of the organizers was thus to lay the foundation of an air-transport system that eventually would have a far wider range of service in Europe. Progress was being made slowly but surely. Then, without warning, the airships designed for a peacetime function were commandeered and ordered to be put to military uses. The task proved a staggering and an extra-hazardous one, beset with disappointments and disasters. Failures served to emphasize the inadequacy of the commercial craft when called upon to meet the varied circumstances of distant flights in time of war. That is to say, the Zeppelins were expected to venture forth in all kinds of weather; to operate in mountainous regions and across broad expanses of open water; and to maneuver at low and high altitudes throughout a range previously not expected of the passenger-carrying dirigibles.

Ewing Galloway, New York

"Graf Zeppelin" moored at Mines Field, near Los Angeles, while eastward bound on her round-the-world flight.

As can be seen, instead of voyaging within a somewhat restricted area as they had done in their years of peacetime service, the Zeppelins were suddenly called upon to journey to points remote from the homeland. This demand necessitated radical changes, tremendous strides forward; and the essays cost heavily in life, material, and money. The war period became virtually a term of experimenting on an extravagant scale; and out of those

Courtesy, Hamburg-America Line

Top—Dining room aboard the giant air liner. Bottom—Commodious salon aboard the "Graf Zeppelin."

strenuous years came Zeppelins far superior in every respect to the comparatively modest craft that the Germans had utilized commercially prior to the outbreak of hostilities. One of the fruits of that struggle was our Zeppelin-built *Los Angeles*, which Dr. Hugo Eckener guided across the Atlantic in October of 1924—traveling *en route* 5,000 miles in the course of 75 hours of flying time.

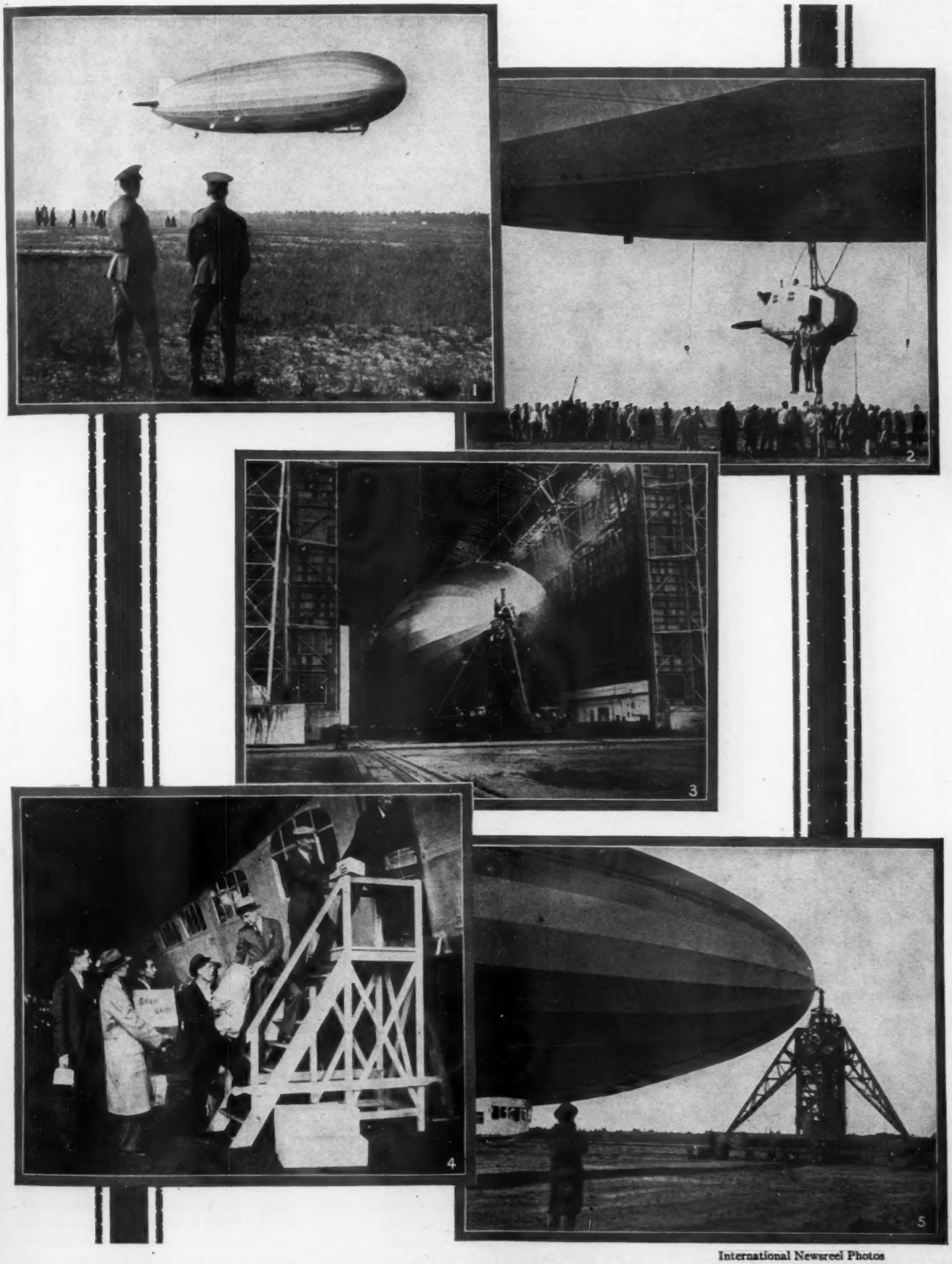
Fine as the *Los Angeles* seemed when we got her, still she marked an experimental stage in the construction of airships; and her outstanding shortcoming is her dependence upon gasoline for fuel—the weight of that fuel greatly limiting her mobility, her ease of handling, and the total effective load she can carry. For training purposes she answers very well; but a gasoline-propelled dirigible would be of reduced value commercially—the essential gasoline cutting down by just so much the capacity to transport passengers and revenue cargo over long distances. Furthermore, a craft so driven is handicapped when expected to operate under all sorts of atmospheric and weather conditions. It is in this respect that the *Graf Zeppelin* marks a radical departure in aeronautical engineering and a very significant improvement. The *Graf Zeppelin* relies in the main upon a gaseous rather than a liquid fuel for her propulsive energy!

The substitution of a gaseous fuel for a liquid one in the case of an airship like the *Graf Zeppelin* is revolutionary in its effect, because the dead load represented by the liquid fuel is dispensed with and the capacity of the craft to carry cargo is increased proportionately while her radius of action—that is, distance she can travel—is correspondingly amplified. Let us explain this briefly. If the *Graf Zeppelin* utilized gasoline to drive her engines, and her fuel tanks were empty but she were otherwise fully laden, then her gas cells carrying lifting hydrogen would be only about two-thirds filled with that buoyant gas. To get her off the ground with her fuel tanks loaded to capacity, it would be necessary to charge her hydrogen cells to their utmost capacity. In that state, the aircraft would rise to a moderate height, where she would become stabilized or balanced with the enveloping air—in other words, she would float without any tendency to change her altitude. If in motion, the airship could be forced to descend or to rise through the action of her horizontal rudders.

With each pound of gasoline expended in operating the engines the dirigible would become lighter, and the lifting effort of her hydrogen cells would increase directly. This would require the "valving" or discharge of some of the hydrogen to compensate for this difference in weight, otherwise the ship would have to make a succession of long slanting flights toward the earth—rising at the end of each of these to a higher level before reaching a stabilizing altitude. The slanting flights would call for a greater expenditure of effort per mile of progress overland. In the case of the *Los Angeles*, which uses liquid fuel, it was needful to rise to a height of 12,467 feet before arriving near enough to the Atlantic Coast on her trip from Germany to make it advisable to release any of the ship's reserve of buoyant hydrogen. The experience gained in crossing the ocean with the *Los Angeles* made it clear that an airship using a liquid fuel would be decidedly restricted in her operating range.

When plans were in preparation for the building of the *Graf Zeppelin*, the meteorologist of the Zeppelin Airship Works, a Doctor Lempertz, advocated the use of fuel gas instead of gasoline for the engines—the gas to

Left—Close-up of the forward gondola and navigating station of the airship. Right—Stern of the "Graf Zeppelin" showing the magnitude of the rudders controlling horizontal and vertical motion.



International Newsreel Photos

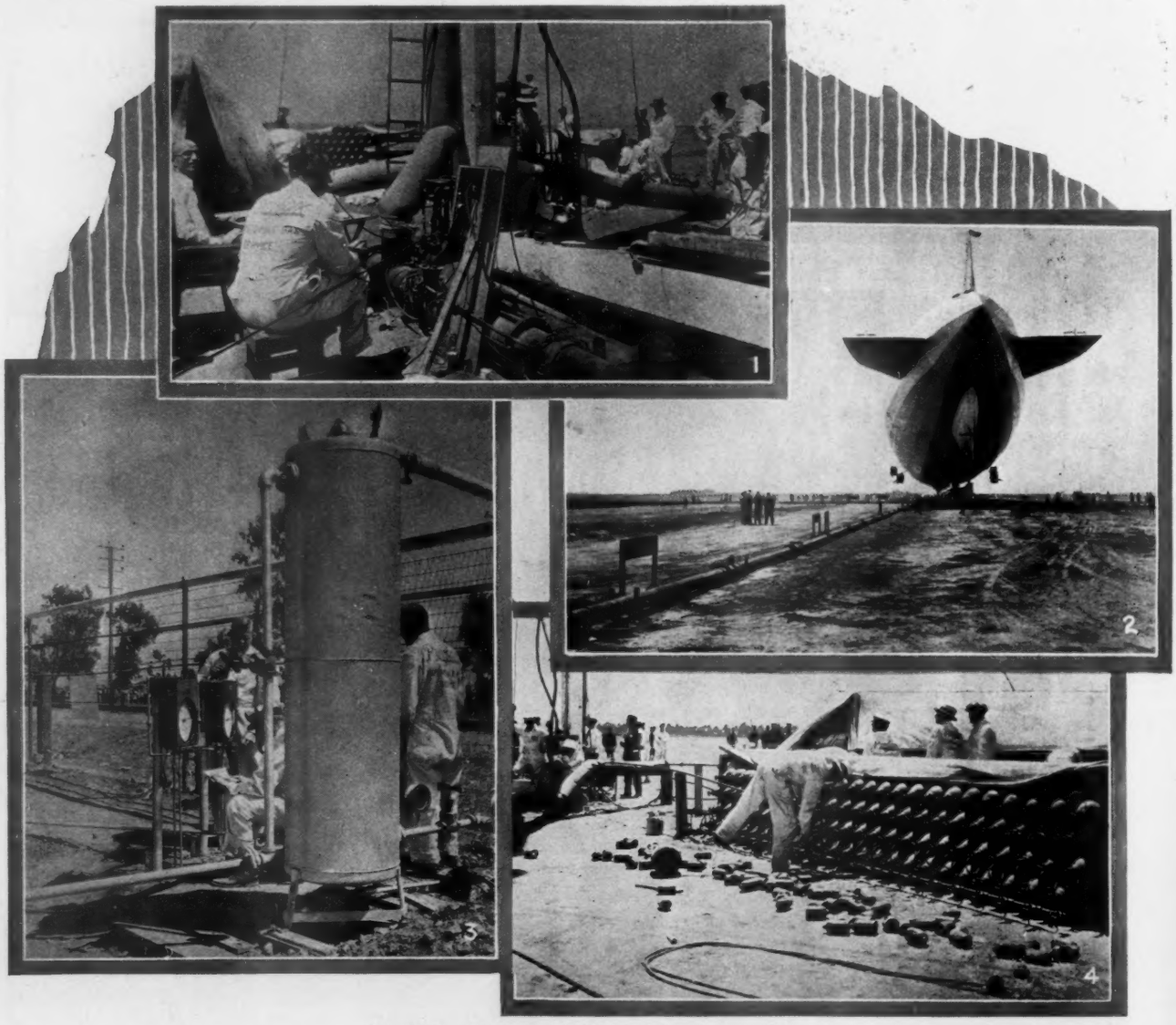
1—"Graf Zeppelin" arriving at Lakehurst, N. J., on her recent flight northward from South America. 2—Members of the ground crew momentarily lifted in the air when the "Graf Zeppelin" was raised by a gust of wind on her arrival at Lakehurst. 3—"Graf Zeppelin", illuminated by artificial light, just before leaving the Lakehurst hangar for her return flight to Friedrichshafen. 4—Checking mail matter and parcels going aboard the airship before the flight back to Germany. 5—"Graf Zeppelin" secured to the new portable mooring mast which forms a novel feature of the Lakehurst Naval Air Station.

have approximately the same specific gravity as the atmosphere at sea level and at a temperature of about 60°F. This meant doing away with a good many tons of dead weight, provided, of course, that a suitable fuel gas could be found. The gas finally hit upon was Blau gas—named after its originator, a German chemist. When refueling in Germany, the *Graf Zeppelin* uses Blau gas made in that country by a well-known firm. Blau gas is somewhat expensive, and is produced by gasifying or cracking gas oil at temperatures between 932° and 1,112°F. Blau gas has virtually the same specific gravity as air; but that fuel is not obtainable in large quantities outside of Germany. This brings us to the steps taken to refuel the airship on her world-circling voyage as well as during her recent journey to South America, to Lakehurst, N. J., and thence back to her home port at Friedrichshafen. In this service American engineers and technicists have figured conspicuously.

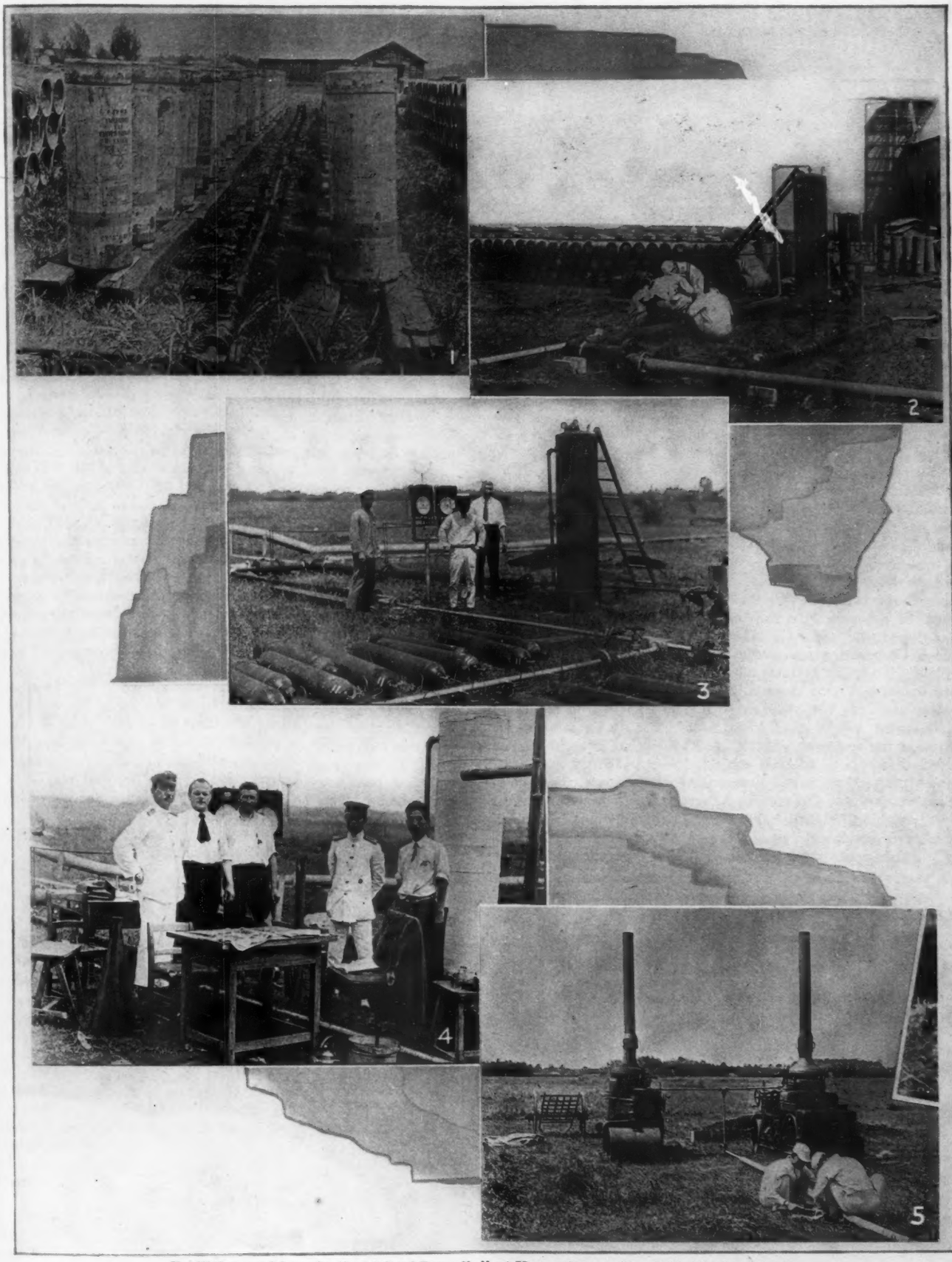
Before the *Graf Zeppelin* flew to America in the fall of 1928, the Carbide & Carbon Chemicals Corporation was approached by the United States naval authorities for information regarding a supply of suitable fuel gas for the ship's homeward flight from Lakehurst. Dr. G. O. Curme, chief chemist of the Carbide & Carbon Chemicals Corporation, recommended either of two gases—namely, ethane or Pyrofax. Ethane is a perfect fuel for the propelling engines of dirigibles. Pyrofax is equally satisfactory as a fuel but is somewhat heavier than ethane. Ethane has this drawback: it is difficult to ship in large amounts owing to the number of heavy cylinders required for its storage while in transit.

When the *Graf Zeppelin* reached the United States on her second trip across the Atlantic and was making ready to start eastward on her flight around the globe, her fuel tanks were filled at Lakehurst with ethane supplied by the Carbide & Carbon Chemicals Corporation from its plant in West Virginia. The gas was sent from that source compressed in numerous steel cylinders. Ethane propelled the airship from Lakehurst to Friedrichshafen —the first leg of the epoch-making aerial voyage.

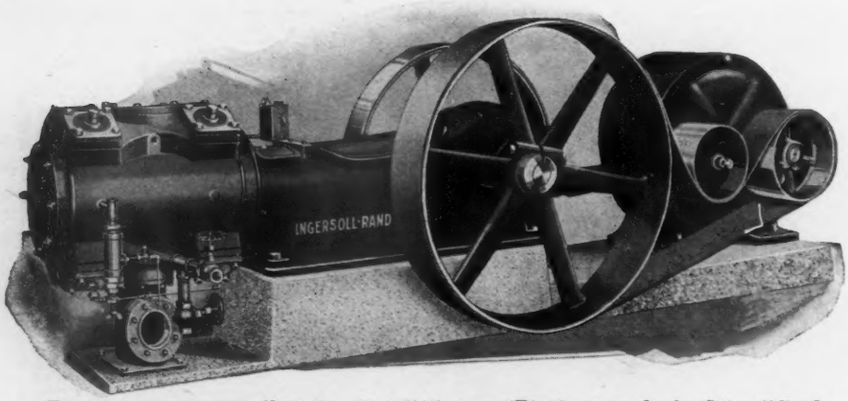
At Friedrichshafen, the craft again filled her fuel cells with Blau gas for the journey from her home port to Tokyo. At Tokyo the ship had to refuel to make the long trip across the Pacific to the vicinity of San Francisco and thence southward to her landing place at Los Angeles. Weeks before the airship reached the Japanese landing field at Kasumigaura, 765 cylinders of Pyrofax had been shipped there from New York City; and that gas—mixed in the proportion of two-thirds Pyrofax and one-third hydrogen, originating in Japan—was used to fill the *Graf Zeppelin's* fuel cells. At Los Angeles, Pyrofax mixed with an equal volume of natural gas was



Refueling the "Graf Zeppelin" at Los Angeles.
1—Control valves, pressure differential manometer, and gas-feed line at base of mooring mast. 2—Airship at mooring mast showing pipe through which gas was supplied by the Southern California Natural Gas Company. 3—Equipment for vaporizing Pyrofax, together with Westcott pressure differential recording meters. 4—Hydrogen cylinders and manifold used in spraying hydrogen for mixed fuel gas.



Facilities used in refueling "Graf Zeppelin" at Kasumigaura Naval Air Station, Japan.
1—Pyrofax being removed from cylinders through a manifold leading to a vaporizer. 2—Workmen engaged in inserting the orifice in the Pyrofax line. 3—The Pyrofax-hydrogen mixing system that combined the two gases before they were delivered to the airship's fuel cells. 4—Mr. M. H. Scott, of the Carbide & Carbon Chemicals Corporation, with a representative of the Zeppelin Airship Works and Japanese naval officers at Kasumigaura. 5—Steam boilers used to operate the vaporizer at the Japanese Naval Air Station.



Type of compressor that handled lifting and fuel gases during the "Graf Zeppelin's" halt at Pernambuco, Brazil, on her recent flight.

utilized to recharge the dirigible's fuel cells—the admixture having a specific gravity of close to 1.05, and was, therefore, only slightly heavier than air. The Pyrofax was delivered at Los Angeles in a special tank car containing 300,000 cubic feet of the fuel in a liquid form. This gasified, when released; and after passing through the mixing apparatus it was delivered to the fuel cells at a pressure of approximately 3 inches of water. This mixed gas is superior to Blau gas, as it contains no poisonous carbon monoxide, has no objectionable odor, and has better anti-knock properties.

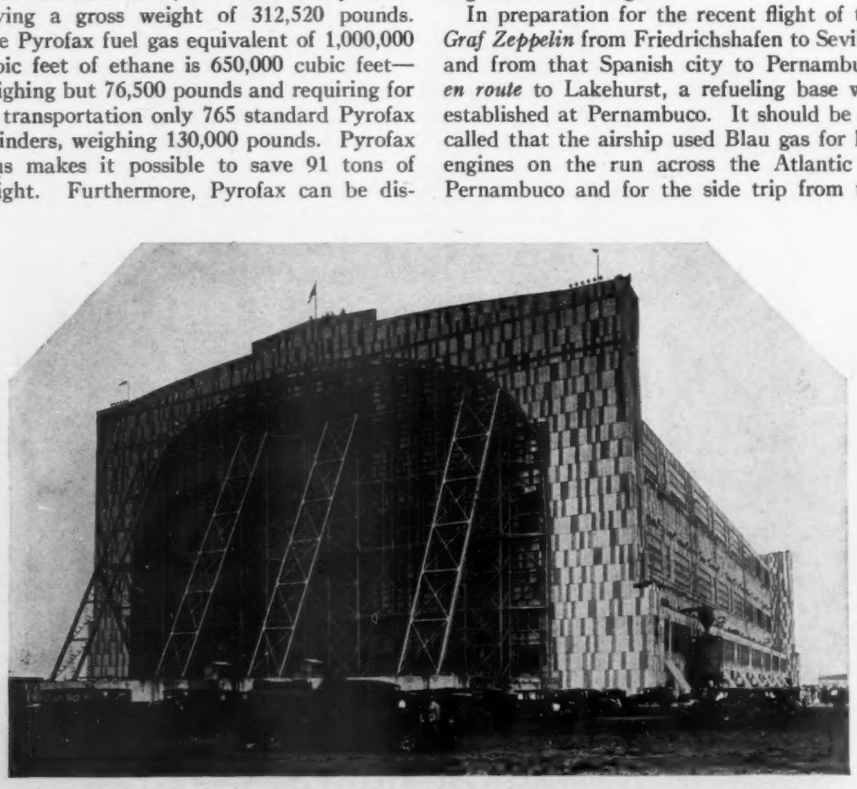
Someone will ask: "What is the advantage in using Pyrofax instead of ethane? Is it not just as economical to ship one or the other of these fuels?" The Carbide & Carbon Chemicals Corporation makes the difference thus plain: To ship 1,000,000 cubic feet of ethane, weighing 79,365 pounds, would require the use of 2,404 standard cylinders having a gross weight of 312,520 pounds. The Pyrofax fuel gas equivalent of 1,000,000 cubic feet of ethane is 650,000 cubic feet—weighing but 76,500 pounds and requiring for its transportation only 765 standard Pyrofax cylinders, weighing 130,000 pounds. Pyrofax thus makes it possible to save 91 tons of freight. Furthermore, Pyrofax can be distributed in the United States in suitably designed tank cars, thereby lowering the cost of delivery.

To those of our readers not familiar with Pyrofax, let us say that it is manufactured by the Carbide & Carbon Chemicals Corporation and used extensively as a fuel gas in rural homes or in those communities that are situated where they cannot obtain gas from established city mains. Pyrofax is a derivitive of natural gas. It has a specific gravity of 1.57 at normal temperature; and in order to adapt it for use in lighter-than-air craft, such as the *Graf Zeppelin*, its specific gravity is made to correspond nearly with that of the atmosphere by the admixture of a suitable percentage of hydrogen, which is about one-sixteenth the weight of air. The hydrogen and the Pyrofax produce a mixed gas having the proper heat content for the powerful Maybach engines on the dirigible.

In preparation for the recent flight of the *Graf Zeppelin* from Friedrichshafen to Seville, and from that Spanish city to Pernambuco *en route* to Lakehurst, a refueling base was established at Pernambuco. It should be recalled that the airship used Blau gas for her engines on the run across the Atlantic to Pernambuco and for the side trip from the latter place southward to Rio de Janeiro; but before leaving Pernambuco for the flight to Lakehurst the fuel-gas cells of the dirigible were replenished and a large volume of hydrogen was pumped into her lifting cells to make up for losses due to leakage and to "valving" at various times during the voyage. To be exact, the *Graf Zeppelin* received 320,000 cubic feet of hydrogen for buoyancy and 760,000 cubic feet of fuel gas—the fuel gas being composed of 510,000 cubic feet of Pyrofax and 250,000 cubic feet of hydrogen. Each cubic foot of mixed gas contains 1,760 B.T.U's; and all the gases were delivered to the *Graf Zeppelin* by an ER-1 compressor of American manufacture. The discharge pressure from the compressor was 10 pounds. This was necessary to overcome friction in the long pipe lines, and made it possible to deliver the gases to the fuel and the lifting-gas cells at a pressure of a few inches of water. The Pyrofax was sent from the United States to Brazil in 3,500 standard steel flasks.

Before the dirigible left Lakehurst on June 2 on her eastward flight to her home port, the Carbide & Carbon Chemicals Corporation supplied her with a total of 860,000 cubic feet of fuel gas; and 180,000 cubic feet of lifting hydrogen was also taken by the ship. The fuel gas was made up of 482,000 cubic feet of Pyrofax, 251,000 cubic feet of hydrogen, and 127,000 cubic feet of ethane. Two tank cars were used to deliver the Pyrofax to the naval air station at Lakehurst. The gas was stored in them at a pressure of 150 pounds per square inch. The outstanding feature of this method of replenishing the expended gases is the far-flung service rendered by the company doing this essential work. It is especially interesting to see how a gas that was intended in the first place for household use has become a primary source of power for long-distance dirigible transportation. Americans have warrant for pride in the part played by our technicists in this spectacular use of lighter-than-air craft.

For emergency service, the *Graf Zeppelin* carries approximately 5,000 gallons of gasoline—her motors being equipped with carburetors that make it possible for her to change instantly from a gaseous to a liquid fuel. The gasoline can be used to get the ship off the ground when she is somewhat heavy or to drive her quickly to higher altitudes when forced to cross mountains or when it becomes desirable to ascend rapidly for one reason or another. By expending the gasoline the ship is lightened—reducing by just so much the load on her buoyant gas cells. In other words, she can make headway while conserving her more desirable gaseous fuel. The substitution of gas for gasoline adds tremendously to the commercial value of lighter-than-air craft and, incidentally, increases the ease with which they can be maneuvered and lengthens the distances they can cover between landing places.

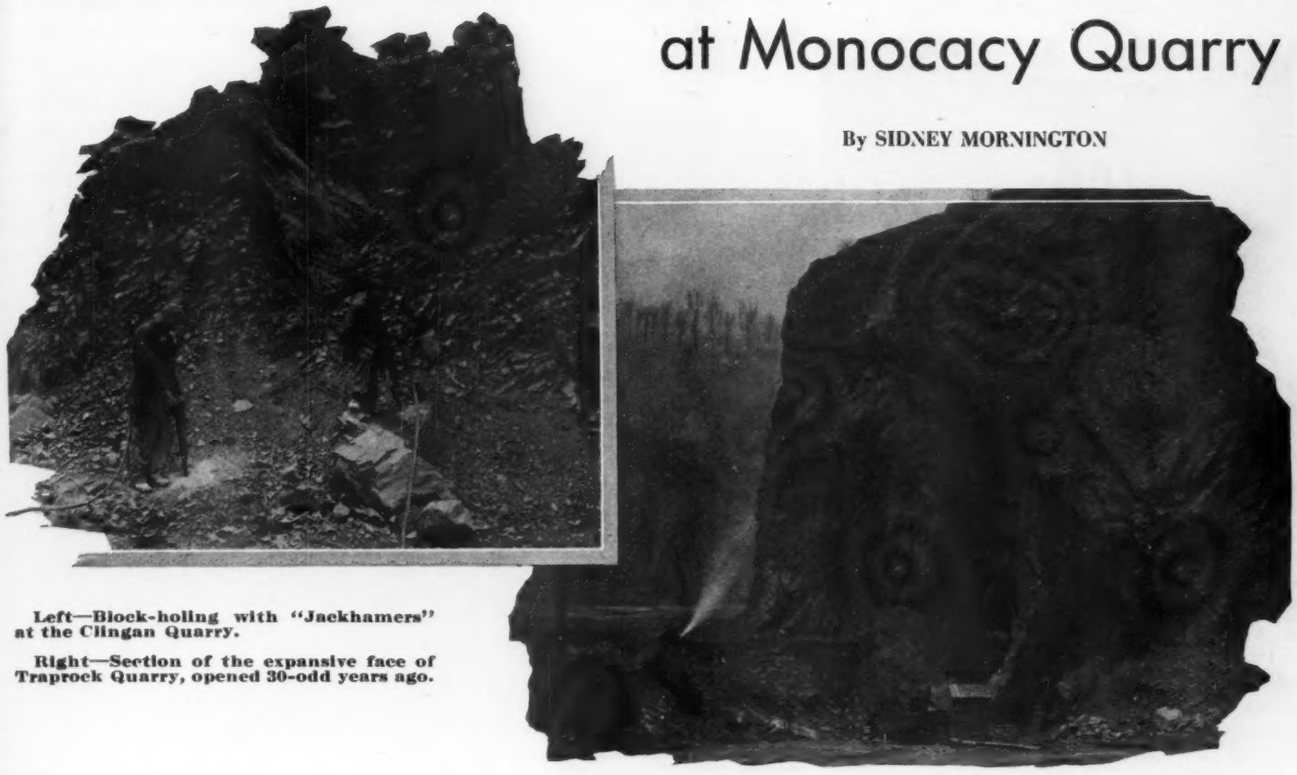


Airship hangar at the United States Naval Air Station, Lakehurst, N. J., capable of accommodating at one time a number of big dirigibles.

A total of 3,500,000 rivets was used in assembling the all-metal dirigible *ZMC-2* built for the United States Navy for experimental work and training purposes.

Single Blast Displaces Great Quantity of Rock at Monocacy Quarry

By SIDNEY MORNINGTON



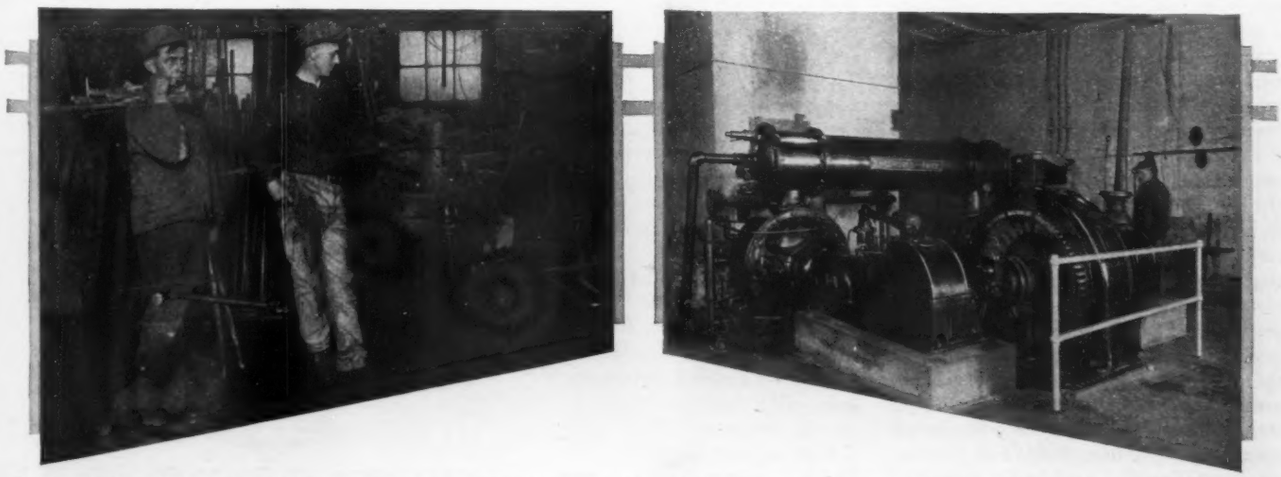
Left—Block-holing with "Jackhamers" at the Clingan Quarry.

Right—Section of the expansive face of Traprock Quarry, opened 30-odd years ago.

THE last day of April of the current year will long remain memorable in Birdsboro, Pa., and the contiguous countryside. On that date, no less than 48,000 pounds of dynamite were detonated successively within a total period of but a fraction of a second—shaking the earth for miles around and filling the air with thunderous reverberations. That blast brought to a climax months of preparation at the Monocacy Quarry of The John T. Dyer Quarry Company.

The purpose of the blast was to bring down from the western end of the Monocacy Quarry sufficient shattered rock to supply for some months the large crushing plant on the premises; and the 24 tons of dynamite used was successful in displacing approximately 325,000 tons of rock—enough to keep the plant going for a period of five months. Up to date, the blast was one of the biggest shots yet set off by this company; and the effect of the explosion was, indeed, a spectacular one not only at the instant of detonation but for many minutes afterwards during which the fragmented trap rock continued to descend in an avalanche that spread in a long slope far out and on to the floor of the quarry. It was an impressive display of the pent-up violence which the seemingly inert-looking sticks of dynamite possessed.

Every quarryman will readily understand the economies made ultimately possible by recourse to a single large blast instead of a succession of much smaller ones over an interval of weeks and possibly months. But a single large shot costs much money even so because a good deal of time is first required to drill and to blast the coyote holes and the connecting lateral drifts, and then the units or groups of explosive must be carefully placed and linked by a powerful and quick-burning fuse that can be set off certainly and surely from a safe distance by electricity. Also, the coyote holes have to be filled with broken rock to tamp them—otherwise the holes would provide relatively easy avenues for the escape of much of the explosive gases and, to that extent, sap them of their shatter-



Left—Blacksmith shop at Clingan Quarry, equipped with a No. 5 drill-steel sharpener. Right—This machine, of 1,302 cubic feet capacity, is the main source of compressed air at the Monocacy Quarry.

Top—Crushing plant viewed from the West. Center—Close-up of the primary crusher. Bottom—Powerful steam shovel on the floor of Monocacy Quarry.

ing effect upon the rock they are designed to displace.

The Monocacy Quarry extends in a generally east and west direction for a matter of 1,300 feet; and the crest of the quarry rises on an average 285 feet above the floor of the pit. The blast set off on April 30 had for its object the shattering of the face of the quarry at the western end horizontally for something like 400 feet—the bench blasted occupying the upper half of the face. To accomplish this, two coyote holes, 4x5 feet in cross section, were driven in from the face of the quarry for distances of 49 and 55 feet 3 inches, respectively. At the inner end of each coyote hole a drift was driven on each side more or less at right angles and generally parallel with the face of the quarry. In this way, each coyote hole and its drifts formed a lopsided T, because the drifts were not of equal lengths. An accompanying diagram makes this arrangement clear. The drifts or laterals were also 4x5 feet in cross section. The drilling was done with both R-12's and L-74's—the "Jackhamers" as well as the drifters being mounted for the purpose.

The portals of the coyote holes were located 102 feet above the quarry floor; and the burden of superposed rock ranged from 125 feet to 140 feet in vertical thickness. The rock to be displaced had an average depth of 52 feet measured inward from the quarry face, and the total horizontal length of the area blasted was substantially 390 feet. From east to west, the laterals of Tunnel No. 3 had a combined length of 175 feet, and within those laterals there were placed nine units of 40 per cent Red Cross dynamite—each unit being made up of from 40 to 60 cases of the explosive and each case holding 50 pounds of dynamite. Tunnel No. 2 had laterals that had a combined length of 152 feet, and within those drifts were arranged eight units made up of from 40 to 70 cases of dynamite. Just beyond the easternmost limits of Tunnel No. 2 there was an 8-inch hole drilled down from the crest of the quarry to a depth of 94 feet. In that hole there was loaded 3,000 pounds of 60 per cent quarry gelatin.

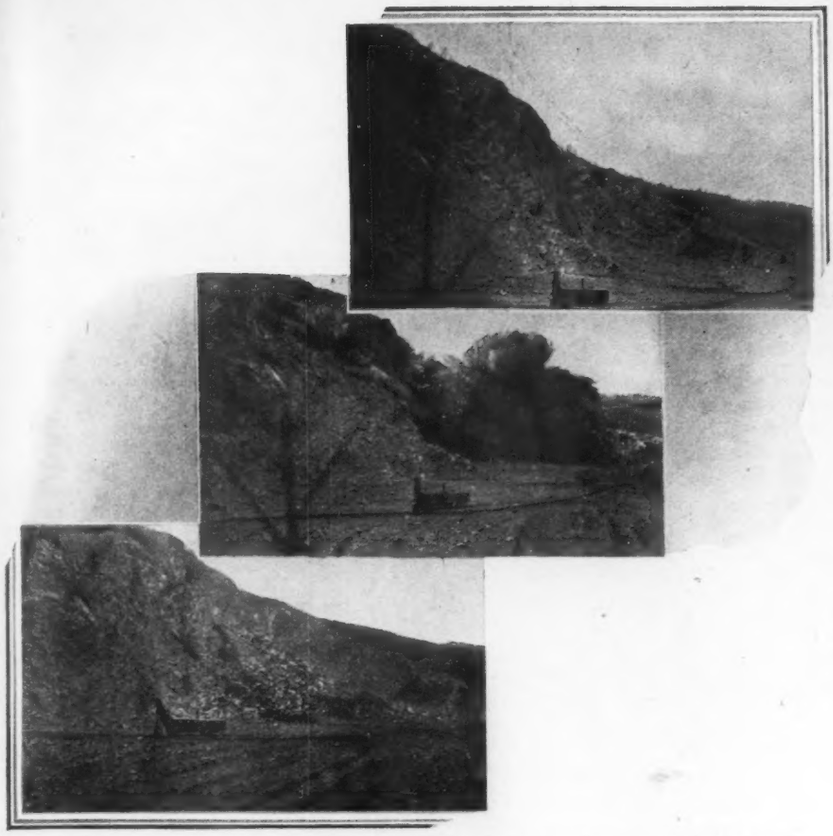
The dynamite in the two tunnels and in the 8-inch hole was so connected by a suitable length of double-counter Cordeau Bickford—that is, lead tubing filled with TNT—that it could be fired electrically from a safe distance. The arrangement was such that Tunnel No. 3 was fired first, then Tunnel No. 2, and, finally, the loaded drill hole—the rock being successively shattered from west to east. Each coyote hole belched its tamping rock like a gigantic shotgun a brief instant before the face of the surrounding rock cracked up and poured downward. The blast was fired at 11 o'clock in the forenoon, and for hours afterwards, at intervals, masses and streams of broken rock of many sizes continued to launch themselves toward the quarry floor. The shot was made under the supervision of Mr. F. T. Gucker, president of The John T. Dyer Quarry Company, and of Mr. William A. Kelly, superintendent of the Monocacy Quarry.

All of the recently blasted rock that can be handled by steam shovels will be loaded directly into quarry cars and moved to the crushing plant, while large pieces of rock too big to be so disposed of will first be blockholed with R-12 "Jackhamers" and then shot into smaller sizes. The crushing plant has a daily capacity of 4,000 tons of rock; and the stone is used in the building of highways, in concrete work, and for railroad ballast—about 50 per cent of the output being sold for the last purpose. The geological formation that is being quarried is composed of a good grade of trap rock; and at various points within and about Birdsboro the rock has been worked for years.

Rock reaching the crushing plant goes first to a 60x84-inch Traylor jaw crusher; and from that unit the rock flows by gravity to a 30-inch Superior McCully gyratory crusher. The crushed rock discharged from the gyratory is picked up by a 60-inch pan conveyor which delivers it to 84-inch revolving screens, by which it is "scalped". The rejects or oversize rock goes back to four 16-inch Superior McCully crushers, and thence by the same 60-inch pan conveyor is carried again to the screens. This closed circuit continues to handle the rock until the pieces are small enough to go through and to be sized by one section or another of the revolving screens. The stone that passes through the sizing screens is moved mechanically to agitated washing screens where it is sprayed with water—the ultimate product falling into different bins according to size. From the bins the crushed rock is loaded directly into cars either for delivery to customers or to be moved to the large storage yard adjacent to Monocacy Station on the Pennsylvania Railroad.

In the past, the practice at the Monocacy Quarry has been to employ well drills working from the crest of the quarry, and therefore recourse to coyote holes and laterals, as in the present instance, represents an innovation. Mr. Kelly is now engaged in another departure in procedure—the idea being to exercise nicer control over blasting operations and to reduce to a minimum interference with work on the quarry floor. A third objective is increased safety. An accompanying diagram illustrates the plan now in hand. At the eastern crest of the quarry, and approximately 125 feet back from the face, there is now being sunk a shaft 5 feet in diameter to an ultimate depth of 115 feet. From this shaft, and at right angles to the face of the quarry, two drifts will be driven to the north and to the south, respectively, and at right angles to these drifts three laterals will be driven on each side. The first

General plan of the two tunnels, with their laterals, showing number and arrangement of cases of dynamite fired.

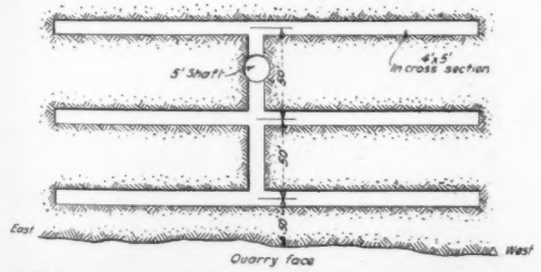


Top—Face of Monocacy Quarry before the blast. Center—Just as the shot was fired. Bottom—The 325,000 tons of rock displaced by the blast.

lateral will parallel the face of the quarry inward at a distance of 50 feet, and the two succeeding laterals will be at intervals of 50 feet. As Mr. Kelly explains: "The object is to blast one drift at a time, and as needed. One of the advantages of this procedure is that the work can be done without interfering with quarry operations. When blasting the drifts they will be filled with water reaching them through the shaft—the water serving as tamping." A 14x12-inch ER-1 Ingersoll-Rand compressor, temporarily placed on the crest of the quarry, supplies the air for sinking the shaft; and it will also furnish air to operate rock drills when driving the various drifts and laterals.

The blacksmith shop at the Monocacy Quarry is equipped with a No. 5 Ingersoll-Rand sharpener, a pedestal punch, and a No. 5 oil furnace, all of the same manufacture, so that drill steels can be promptly and properly conditioned for the work expected of them. The quarry's main source of compressed air is a PRE-2 compressor capable of supplying 1,302 cubic feet of air per minute. For scattered jobs on the property, the company utilizes a 9x8-inch Type 20 portable compressor; and there is generally enough to be done in the way of drilling, riveting, and maintenance work to keep the unit fairly busy.

In addition to the Monocacy Quarry, The John T. Dyer Quarry Company operates what is known as Traprock Quarry at Birdsboro, Pa., and Clingan Quarry, at Robeson Station, Pa. Traprock Quarry was opened in 1894, and Mr. Harry Schwartz is in charge of it, while Clingan Quarry, supervised by Mr. Levi Carson, was opened in 1911. At both of these quarries the primary shooting is done with well holes, and the practice is to use BCR-430, R-12, and S-49 "Jackhamers" in doing the necessary block-holing of large pieces of rock. These quarries are ably managed by their respective superintendents. Traprock Quarry produces day in and day out a matter of 1,000 tons of crushed stone, while Clingan Quarry averages 1,200 tons every 24 hours. The output of all three of the Dyer quarries is utilized mainly for the purposes already mentioned.



Plan of shaft, drifts, and laterals now being sunk and driven at the eastern section of Monocacy Quarry.

Chicago has in operation an underground electric freight-handling system that has lessened traffic in the streets of the congested business district by as many as 100,000 truck movements monthly.

SPRAY-PAINTING LUMBER IN BULK

A COMPACT, portable spray-painting machine, in use in the passenger- and freight-car repair shops, at Montreal, Que., of the Canadian Pacific, has turned the daily task of painting approximately 100,000 linear feet of lumber into an operation that has ceased to be a source of trouble. Prior to its introduction, the boards were painted by the brush method which did not always meet requirements both as to quantity and quality.

The machine that has revolutionized this phase of the shop operations consists mainly of a spraying chamber equipped with sixteen nozzles—eight on either side disposed in two rows of three and five nozzles each, the latter being uppermost; of a feeding mechanism; of a spray condenser; and of an air drier. The outfit is mounted on four wheels, is completely encased in sheet steel, and the detachable top of the spray chamber is in the form of a gable so that the paint will run down its sides and back into the supply tank instead of dripping on to the lumber during its passage through.

At the delivery end there is an adjustable platform which facilitates feeding the lumber horizontally into the machine by the aid of two grooved iron rollers. The lower roller is keyed to the driving shaft of an air motor: the upper one can be adjusted so as to take 4x12-inch boards and less. Depending upon its condition and the amount of paint to be applied, lumber can be run through the machine at a rate of from 60 to 200 feet per minute—the speed being controlled by the air-motor throttle.

Each of the sixteen sprays is made up of two nozzles set at right angles to each other and delivering, respectively, paint and compressed air. This arrangement is said to insure well-nigh perfect atomization. The direction of the spray is regulated by levers on one side of the machine, while the valves controlling the flow of air to the nozzles are on the opposite side. Compressed air is also employed periodically to agitate the paint in the tank—a ½-inch diameter pipe, perforated with ⅛-inch holes, being run lengthwise along the tank bottom for this purpose.

The machine is so designed that no paint fumes nor spray can escape, making it possible to use it indoors with safety. The air pressure built up within the chamber that might force the fumes out through joints, etc., finds its way into the bottom of the spray condenser through a 4-inch pipe. An air line is also provided to accelerate this exhaust. The top of the condenser is closed with a counter-weighted lid which is so secured that it can be lifted by the exhaust air, thus permitting its escape into the atmosphere. Any paint that may be contained in the exhaust air is collected in the condenser by a series of baffle plates. This paint is reclaimed and led back to the tank through a 2-inch pipe. The function of the drier is to remove from the compressed air any moisture that might cause the air to freeze when the paint spray is operated outdoors in cold weather.

As used at the Angus shops of the Canadian Pacific, four men are assigned to a machine—

two at the feeding and two at the discharge end. During a test run, according to the *Railway Mechanical Engineer*, one machine, with a full crew and in an 8-hour working day, coated 42,657 linear feet of lumber with 35.85 imperial gallons of paint—the equivalent of 892 square feet of surface per gallon. This work was done at a cost for labor, including the placing of loaded and unloaded trucks alongside the outfit, of 31 cents per 1,000 linear feet.

MORE MANGANESE FROM DOMESTIC SOURCES

THE United States is the world's largest consumer of manganese, but, in the past, has had to depend mainly upon foreign sources of supply for this so-called key metal that is so essential to the steel industry. Therefore, it is exceedingly interesting to learn that the Anaconda Copper Mining Company, following tests made by the United States Bureau of Mines at its Rolla, Mo., experimental station, has succeeded in placing upon a commercially practicable scale a process of flotation which makes it possible to separate both rhodochrosite and oxide ores from their accompanying gangue minerals. Large reserves of these low-grade ores are known to exist in some of our western states.

Last December, says the *Mining Congress Journal*, a test run was started in one of the Anaconda's plants, and since that time approximately 12,000 tons of rhodochrosite ore —averaging between 29.5 and 30 per cent metallic manganese and in excess of 20 per cent silica—have been treated there by the flotation process. The concentrates have ranged from 38 to 40 per cent metallic manganese and less than 6 per cent silica. Recovery of manganese in the flotation plant has averaged about 95 per cent. The ore is being treated at the rate of 300 tons per day, and 200 tons of the finished product—the present maximum output—is being shipped daily to Butte for nodulizing. The nodulized material runs about 60.8 per cent metallic manganese and 6.9 per cent silica—which is said to be the highest grade of manganese ore ever marketed. The metal is being used by steel and ferro-manganese mills in the Middle West and the East.

LIQUID FUEL FROM COKE

CONSIDERABLE importance attaches to certain tests now being conducted in Germany at the plant of the Ruhr Chemical Company in an effort to determine the practicability of the Fischer process of producing liquid fuel from coke. This process differs from others of its kind now in commercial use in Germany in that only ordinary pressure and medium temperature are required.

The basic materials being experimented with consist of soluble glass, furnace gas, smelting-works gas, and mixtures of carbureted hydrogen and furnace gas. All the products of the oil industry ranging from gasoline to solid paraffin are extracted directly in pure condition. Five tons of coke are needed to yield one long ton of gasoline.

THE AIRPLANE AND ITS ENGINE, by Charles Hugh Chatfield and Charles Fayette Taylor. An illustrated volume of 329 pages, published by McGraw-Hill Book Company, Inc., New York City. Price, $2.50.

THE authors of this work have aimed to furnish information for what they appropriately term "the intelligent middle-class aeronautical readers" composed of persons earnestly interested in acquiring a sound knowledge of the basic facts and theories of the airplane. These people are assumed not to desire to give the subject the intensive study which is essential for the designing engineer or the expert mechanic. Undoubtedly, the purpose outlined is an excellent one, because it is calculated to appeal to the steadily growing number of persons that want to know more about aircraft and their driving motors. It is another way to make the populace generally more airminded.

The book demands of its readers only such knowledge of physics and mechanics as they would be likely to acquire in the first two or three years of a high-school course; and all mathematical treatment is of the simplest sort. As the authors state: "For the sake of brevity we have confined ourselves strictly to the modern airplane, avoiding the historical as being of less interest than the contemporary, and omitting all discussion of other types of aircraft, which at present are of secondary importance." We believe the book will interest and help many.

HOW TO READ BOOKS, by Llewellyn Jones. A book of 229 pages, published by W. W. Norton & Company, New York City. Price, $2.50.

LLEWELLYN Jones is the literary editor of the Chicago Evening Post, and in a prefatory note he writes: "The present book is addressed simply to the reader of books. And its aim is to help him to enjoy them—not to improve his mind or to urge him to change or purify his tastes . . . I have tried to write simply, and if the chapter on the technique of poetry looks formidable, that is only because diagrams and diacritical marks always do look formidable." The keener the senses the more apt one is to appreciate the beauty, the force, and the appeal of another's work; and no one can read the author's book without being more sensitive to the craftsmanship of the writers of books.

ARITHMETIC OF ELECTRICITY, by T. O'Conor Sloane, A.M., E.M., Ph.D. A book of 230 pages, published by The Norman W. Henley Publishing Company, New York City. Price, $1.50.

THIS volume is exceptional in that all electrical calculations treated by it are reduced to a series of rules that involve the use of only ordinary arithmetic. The purpose of this procedure is to help electrical students that have little if any working knowledge of algebra; and these persons number a great many thousands. Doctor Sloane has performed in this case, as in several others, a good job that will inevitably be of widespread benefit.

THE FUTURE MOVEMENT OF IRON ORE AND COAL IN RELATION TO THE ST. LAWRENCE WATERWAY, by Fayette S. Warner, C.E., M.B.A., Ph.D., Political Science Department, University of Pennsylvania. An illustrated book of 195 pages, published by the University of Pennsylvania Press, Philadelphia, Pa. Price, $3.00.

WILL the St. Lawrence waterway pay; is there need of such a freight route between the Great Lakes and the Atlantic Ocean? These questions are asked and argued just once so often, and the sooner the general public is thoroughly informed the sooner will it be possible for the two countries immediately concerned to act for the common good. The present volume is the outcome of a notably thorough study of one aspect of the subject, and a very significant one at that. The author deals specifically with the movement of iron ore and coal, but he considers at the same time how enormously beneficial would be a direct water route to foreign markets for an area that produces more than 30 per cent of the world's total grain supply. He points out that the Minnesota iron ores may be exhausted within twenty years, and it will then be necessary either to move the dependent industries east or to open a route through the Great Lakes in order to facilitate bringing in high-grade ores from foreign sources. Mr. Warner is convinced that the projected St. Lawrence waterway will pay for itself even more readily than the Panama and Suez canals.

YEARBOOK OF AGRICULTURE, 1930, prepared by the United States Department of Agriculture. An illustrated volume of 1,080 pages, published by the United States Government Printing Office, Washington, D. C. Price $1.50.

THIS yearbook, like those issued by the department for the preceding three years, contains a great variety of recent scientific, technical, and economic information—in short, popularly written articles. In addition to these, there are numerous agricultural maps and statistical tables—the whole constituting a comprehensive chronicle of contemporary progress in agricultural science and practice. While the object of this annual is to help towards the practical application of a continually increasing fund of scientific knowledge, still the information is of general value to the public at large—serving the twofold purpose of showing what the Government is doing to help the farmer and at the same time telling the people things about agriculture and its varied and, at times, complex phases.